NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA

THESIS

THEATER BALLISTIC MISSILE DEFENSE: MODELING AND ANALYSIS OF THE MARINE CORPS "HAWK" MISSILE DEFENSE SYSTEM

by

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December 1995

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REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE December 1995	3. REPORT TYPE AND DATES COVERED Master's Thesis

4. TITLE AND SUBTITLE **THEATER BALLISTIC MISSILE DEFENSE: MODELING AND ANALYSIS OF THE MARINE CORPS "HAWK" MISSILE DEFENSE SYSTEM**	5. FUNDING NUMBERS
6. AUTHOR(S) Monroe, William J. F.	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey CA 93943-5000	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.	12b. DISTRIBUTION CODE

13. ABSTRACT *(maximum 200 words)*

This thesis develops the concept of integrating IDEF modeling with matrix analysis to explore the current state of the Marine Corps, "As Is", Theater Ballistic Missile Defense information architecture. It demonstrates the possibility of using matrix analysis in conjunction with IDEF modeling to identify deficiencies within an existing information architecture. Using this framework, new technologies and advancements can also be measured to ensure they accurately address deficiencies identified in the analysis. Additionally, this thesis incorporates the knowledge garnered from this analysis into a possible, "To Be", physical architecture for the year 2002. It examines the "As Is" physical architecture, technological advances, and environment enhancements, and proposes one possible infrastructure for future theater missile defense.

Models have traditionally been developed as analysis vehicles which conform only to administrative processes. This led to minimal utilization of the application and its capabilities. Matrix analysis allows for accurate investigation and documentation of information and systems useful in the development of new technologies. This thesis demonstrates that modeling, combined with matrix analysis, can also be incorporated for tactical processes.

14. SUBJECT TERMS Theater Ballistic Missile Defense, High Altitude Will Kill (HAWK) Missile System, IDEF Modeling, Matrix Analysis	15. NUMBER OF PAGES 261
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18 298-102

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THEATER BALLISTIC MISSILE DEFENSE: MODELING AND ANALYSIS OF THE MARINE CORPS "HAWK" MISSILE DEFENSE SYSTEM

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Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
December 1995

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I. INTRODUCTION

"Operation DESERT STORM was the first Theater Missile Defense (TMD) experience for U.S. Forces. This experience will significantly influence TMD efforts in the near term. There was only one weapon (the Patriot PAC-II system) capable of engaging Theater Ballistic Missiles (TBM) during DESERT STORM."

Theater Air Defense BMC4I Vision for Theater Missile Defense
Air Combat Command Directorate for Requirements Aerospace Control Division
1 October 1994

"The USMC TBMD system will evolve from the Marine Corps' existing Tactical Air Operations Center (TAOC)/Sector Anti-Air Warfare Center (SAAWC), AN/TPS-59, and USMC High Altitude Will Kill (HAWK) missile system."

Theater Missile Defense Command and Control Plan (DRAFT)
11 April 1995

A. BACKGROUND

This thesis provides the Marine Corps and other Department of Defense (DOD) activities with insight into three areas. First, through the use of an IDEF 1X application, development of a detailed "As Is" model of the Marine Corps Theater Ballistic Missile Defense (TBMD) architecture is provided.[1] The "As Is" model is used as a tool to aid in the examination of the command and control structure, the information exchange, and the interoperability of the Marine Corps' High Altitude Will Kill (HAWK) missile system in relationship to Theater Missile Defense (TMD). Also, after its completion, the model assists in the analysis of the Marine Corps' TBMD system. The modeling of a complex collection of processes is an extremely difficult task. To ensure the goal of developing a reliable

[1]This was accomplished by starting with the model constructed by Michael E. Lewis and David J. Steffens [Ref. 10].

model is accomplished, is was necessary to determine which application tool would provide the best support.

The IDEF 1X modeling application was selected because it aids in the production of intricate diagrams, of extremely complex systems, which were previously unobtainable through conventional means. In the past, analysts and managers relied upon flow charts and tree diagrams to aid in the mapping and studying of an operational system and its processes. However, as the processes grew more complex and the operational systems became more technologically advanced, the ability of a flow chart and/or tree diagram to accurately portray a comprehensive picture diminished. With the development of the IDEF 1X tools, the capabilities needed to model a system and its processes, down to the smallest detail, were attained. Once a model is completed, its thoroughness allows it to be used to further the study of the operational system and its processes through matrix analysis.

Second, this thesis, through the use of matrix analysis, provides insight and guidance to a proposed 2002 "To Be" Marine Corps TBMD model. The matrices, individually, are not very helpful in the overall analysis because they represent a picture of specific areas of interest. However, when combined and taken as a whole, the matrices provide insight into the complete TBMD system. These areas of analysis are: Intelligence Data Flow, Battle Management Information Architecture Cohesiveness, and Battle Management Information Support. Intelligence Data Flow examines the ability of the architecture to input, receive, process (fuse and correlate), store, display, and disseminate intelligence data on TBM operations. Specifically, the analysis provides information that allow answers to be developed concerning the flows between systems and their disconnects (who receives, who processes, and who uses the information/intelligence). Battle Management Information Architecture Cohesiveness explores the ability of the system to provide the decision makers with the appropriate information, in a timely fashion, and in an understandable format. More specifically, the analysis provides information, to the decision maker, on the data flow how it affects performance. Finally, Battle Management Information Support examines the TBMD system's ability to process, build, and maintain a situation display based on track data and point data received from local and remote sensors over data links from other

agencies. Further, it looks at the TBMD system's ability to distribute the data required by the launchers and other appropriate command and control (C2) agencies. Specifically, this analysis provides information on the systems contained within the TMD architecture and their ability to adequately provide input and output of information and intelligence in a timely, efficient manner and their ability to provide that information and intelligence in a correct and usable format.

Third, this thesis, through its use of models and matrices, provides a possible means for conducting successful analysis of IDEF 1X models. Increasingly, over the past five years, the DOD has invested millions of dollars and thousands of man hours constructing models using IDEF 1X tools [Ref. 9]. Unfortunately, these models, to the non-subject matter experts, are sometimes confusing and attention consist of no more than a cursory glance [Ref. 9]. Matrices, combined with an IDEF 1X model provide the tools necessary to conduct an accurate matrix analysis. Matrix analysis is useful in the examination of complex or complicated operating systems. Examining the development of the matrices, and their relationship to the model, is one possible method of matrix analysis.

B. OBJECTIVES

The objective of this thesis is to define a seamless TBMD information architecture that can be supported by systems, operators, and available transmission mediums. This is done by modeling the existing TMD infrastructure (systems, information flow, interoperability, activities, C2 facilities, etc.), using matrix analysis to identify areas of concern within the infrastructure, and developing a possible "To Be" architecture for Marine Corps' TBMD in the years proceeding 2002. Through the use of IDEF 1X modeling, the responsibilities and transactions of all Marine Corps entities involved in the TMD process will be identified. The author uses the information from the model, the matrices, and the matrix analysis to facilitate the identification of current technologies and initiatives that best support critical roles in the proposed architecture.

C. ORGANIZATION OF THESIS

This thesis is organized into five chapters and six appendices. A bibliography is included to supplement the list of references and to provide the reader with resources for further research. The first chapter contains the introduction and overview of the thesis. The second chapter explores mitigating factors associated with building the "As Is" model and the matrices and conducting the analysis. The third chapter examines the function of the HAWK missile system, identifies discrepancies with the existing system, and proposes a possible infrastructure for a "To Be" TBMD architecture. All appendices of this thesis support Chapter III. Appendix A illustrates the existing Marine Corps "As Is" TBMD architecture. Appendix B illustrates the IDEF 1X model developed to investigate processes, information flows, and interoperability of Marine Corps HAWK missile system within the context of TMD. Appendices C and D provide further insight into the IDEF 1X model by providing comprehensive definitions of the activities, the inputs, the outputs, the controls, and the mechanisms. Appendix E contains an examination of the individual matrices, an analysis of each matrix, and the information the matrices provide. Appendix F illustrates the proposed architecture for the Marine Corps HAWK Missile system in the year 2002. Chapter IV provides information on the development and possible impact of technologies associated with the proposed "To Be" architecture. Chapter V is the thesis conclusion and contains recommendations for further research.

II. MODELS AND MATRICES

A. INTRODUCTION

In order to conduct a thorough analysis of the existing Marine Corps Theater Ballistic Missile Defense (TBMD) architecture and provide insight into a proposed "To Be" TBMD architecture for the year 2002, three conditions are satisfied. First, an IDEF model of the existing Marine Corps TBMD system is constructed. The model is necessary because it provides crucial insight into the command and control, information flows, and interoperability of the combined Tactical Air Command Center (TACC)/Tactical Air Operations Center (TAOC)/Sector Anti-Air Warfare Center (SAAWC), AN/TPS-59, and HAWK systems. Second, using information from subject-matter experts and information from the IDEF model, matrices are constructed. The matrices, a total of fourteen, provide information that yield a more accurate understanding of the information contained in the model. Finally, using information from the IDEF model and the matrices, a thorough matrix analysis is conducted. This analysis is instrumental in identifying areas within the TBMD architecture that may be improved.

B. IDEF 1X MODEL

It is important to note that the model presented in this thesis is not considered finished. The Marine Corps TBMD architecture is so dynamic and complex that any model constructed soon becomes outdated. The model presented in this thesis (Appendix B) provides the reader with a nucleus that will enable him/her to better visualize and comprehend the current TBMD process.

1. Marine Corps "As Is" TBMD Model

The author will construct the "As Is" Marine Corps TBMD model in three steps. First, a prior IDEF "As Is" model [Ref. 10], is used as a starting point. After consulting with subject matter experts at Naval Command, Control, and Ocean Surveillance Center (NCCOSC) and Marine Corps Combat Development Center (MCCDC) [Ref. 5], a decision was to made to start with the existing model because it presented a good base of information

and only needed restructuring and editing of the information flows to be considered complete. The process for restructuring the model is as follows:

1. The existing model is examined (starting at the lowest levels and working up) to ensure that all arrows are traceable throughout every level. All arrows (inputs, outputs, controls or mechanisms) that were missing or deemed unnecessary to the new model were identified.

2. All activities are examined to ensure they were correct and required. If an activity is insufficiently defined or not required in any way, it will be redefined or eliminated. The activities are also examined to ensure that correct inputs, outputs, controls, and mechanisms are present. If any arrows are missing or identified as being unnecessary, they will be identified.

3. All levels are redrawn to show the changes that were identified.

4. A subject-matter expert is consulted to ensure the correctness of the proposed changes. This is an important step because any mistakes made during reconstruction could lead to an improper analysis later on.

5. Any and all corrections made by the subject-matter expert are incorporated into the drawings.

6. The drawings are reexamined for correctness by the author and NCCOSC personnel before proceeding further.

The second step in reconstructing the model is to develop an electronic version of the model by inputting the drawings into the computer. It was decided the this will be accomplished using the BPWin 1.5.1 modeling tool. Starting at the uppermost level and working down is the best way to ensure that all information flows track correctly throughout the model. BPWin allows the user to project down to the next level and, at the same time, project all the necessary arrows for the next lower level. It is necessary to go down seven levels in order to accurately depict the TBMD process.

Once the model is stored electronically, the final step in reconstructing the model is to use BPWin to print out the Activity and Arrow names. The activity[2] and arrow names are defined to provide the reader with a better understanding of the processes involved in conducting TBMD within the specified environment (i.e., HAWK Missile Battalion).

2. Marine Corps "As Is" TBMD Architecture

The Marine Corps "As Is" TBMD architecture is constructed using information provided by subject-matter experts and information contained in research material [Refs. 5 and 9].

BPWin is used for this application because of the program's flexibility and versatility in constructing DFD diagrams.

3. Marine Corps "To Be" TBMD Architecture

The Marine Corps "To Be" TBMD architecture is constructed using information provided by subject-matter experts, information contained in research material, and information provided by the matrix analysis [Refs. 5 and 9].

BPWins is used for this application because of the program's flexibility and versatility in constructing DFD diagrams.

C. MATRIX CONSTRUCTION

The key to a successful analysis lies in the construction of the matrices. The best approach is to build matrices that lead back to the model. However, the model alone does not provide enough information with which to construct the matrices. The first step, therefore, is to consult with outside sources to help shape and define the boundaries of the analysis. The model does not provide answers about how to construct the matrices. Rather, the matrices are constructed in such a fashion as to provide insight about, and into, the information contained in the model.

After consulting with NCCOSC and MCCDC, three areas of concern were identified [Refs. 5, 9, and 13]. They are: Intelligence Data Flow, Battle Management Information Architecture Cohesiveness, and Battle Management Information Support. The author chose

[2]The Activities definitions are still under construction as noted in Appendix C.

to use a hierarchical approach to build the matrices. Each matrix, in some way, contributes to the construction or analysis of another matrix. This procedure is followed until a series of matrices are constructed that enabled the three areas of concern to be adequately covered.

The construction of the matrices started with the most general areas first; C2 Facility to Activity, Intelligence to Activity, Equipment to C2 Facility, Equipment to Communication Type, Outputs to C2 Facility, and Outputs to Equipment. These matrices provide needed information to construct more in-depth matrices. Also, these matrices present a general view of the information contained in the model. Next, the information from the first set of matrices is used to construct a second set of matrices that further address the areas of concern defined earlier. The matrices include: Intelligence to Equipment, Intelligence to Communication Type, Communication Type to C2 Facility, and Intelligence to C2 Facility. These matrices present a more concise view of what the model has to offer. However, the two sets of matrices, even when combined, do not accurately portray the model in terms needed to conduct a comprehensive analysis.

A final set of matrices are needed to accomplish this task. This set of matrices are more difficult to construct. Not only do they contain information from the first two sets of matrices, they are also constructed in such a fashion as to depict two two-dimensional views within one matrix. The matrices constructed include: Equipment to TACC-Communication Type-TAOC, Equipment to TAOC-Communication Type-BCP, Intelligence to TACC-Equipment-TAOC, and Intelligence to TAOC-Equipment-BCP. This final set of matrices, when combined with the first two sets of matrices, are enough to accurately portray the model. They also provide the author with enough information about the model to ensure a thorough analysis is conducted.

D. MATRIX ANALYSIS

It is important to note that one purpose of this thesis is to demonstrate that matrix analysis can be assimilated into the modeling process to help facilitate the understanding of difficult conceptual models. In this particular instance, the analysis aids in reinforcing defined areas of concern addressed before matrix construction was attempted.

Once the model and the matrices are constructed, the final step is to do the matrix analysis. The first step is to identify which areas of concern each matrix or combination of matrices addressed. Next, the matrices are grouped to ensure that all possible combinations have been identified. Once this is completed, the matrices and model are used during analysis.

There is no right or wrong way of doing an analysis. The process is dictated by the information available and the information sought. In this case, the procedure is simple. The IDEF model depicted the Marine Corps "As Is" TBMD architecture accurately enough to provide assistance in building the matrices. The matrices are built after defining the boundaries the author wants to explore. The information available is contained in the model and matrices previously identified. The information sought will be addressed after the matrix boundaries are defined. The analysis process proceeds along the same direction.

E. CONCLUSION

Once again it is important to note that the building of a model does not necessarily provide enough information about a system or process to be effective. The information contained in the model represents the processes and does provide information concerning equipment or information flow. To present a complete, comprehensive view of a system or process, such as TBMD, a combination of a model, matrices, and matrix analysis is needed. The matrices and matrix analysis provide that missing information on systems and information flow that is not apparent in the model. The model must present an accurate picture of what is happening within a system or process. Once developed, it must be carefully reviewed by a subject-matter expert to ensure both completeness and correctness. The next step, when undertaking a project of this nature, is to construct the matrices. The information required for construction of the matrices, once again, is not found within the model. The model only represents the processes, it does not provide information on where the disconnects might be or where a problem might arise. That information is obtained from subject-matter experts. Once the boundaries of the analysis are defined, the matrices can be constructed. Note, however, that the matrices must be fashioned in such a way as to lead

back to the model. This is important because the structure of the matrices provides for questions of who, what, why, and when and the information in the model provides the answers. The matrices must be structured precisely in order to address the boundaries used to defined the analysis. The matrix analysis is the last step in presenting a complete, comprehensive view of a system or process. This is the most arduous facet of the three. However, if the first two steps are accomplished well, the analysis is more labor intensive then it is mentally challenging.

III. ANALYSIS

A. INTRODUCTION

In joint operations, the Marine Corps component commander is responsible to the Joint Force Commander (JFC) for the Marine Corps' Anti-Air Warfare (AAW) and Theater Missile Defense (TMD) operations within the assigned Area of Operations (AO). TMD for the Marine Air Ground Task Force (MAGTF) is normally delegated to the Aviation Combat Element (ACE) Commander. The ACE Commander further delegates authority for MAGTF TMD attack and active defense operations within the MAGTF's AO to the Sector Anti-air Warfare Coordinator/Tactical Air Operations Center (SAAWC/TAOC). The Marine Corps Tactical Air Command Center (TACC) AN/TPS-59 radar provides surveillance, early warning, and queuing for the MAGTF. The AN/TPS-59 is also an integral asset to the High Altitude Will Kill (HAWK) Missile Battalion.

The HAWK is the Marine Corps' primary AAW/TMD weapon. It can operate as a stand-alone system or it can be integrated with other existing air defense platforms such as the Army's PATRIOT Battery or the Navy's AEGIS SM-2. Over the years the HAWK has been upgraded repeatedly to defend against increasingly sophisticated threats. It has also been programmed for upgrades so that it remains a contributing participant in TMD operations. However, even with the best technology in place, TMD is still not being performed in the most effective manner in the author's opinion.

Theater Missile Defense (TMD) is an integral part of the Marine Corps Information Architecture. The Marine Corps Information Architecture must be defined and analyzed using reference points and methodologies that ensure that TMD is fully integrated and supported by the Marine Air Ground Task Force (MAGTF) Command, Control, Communication, Computers, and Intelligence (C4I) architecture.

This analysis is a two phase operation. The first phase consists of examining the Marine Corps "As Is" TBMD architecture through IDEF modeling. Initial emphasis is placed on the determination of the "As Is" environment's strengths and weaknesses within the contexts of the areas of concern. These concerns are identified in Chapter II. Analysis

of the "As Is" architecture is accomplished through the construction of matrices that relate such areas as equipment, intelligence, activities, and C2 Facilities to support the analysis. The matrices, when combined and then coupled with an IDEF 1X model, provide a clear picture of the TBMD architecture. The second phase of this analysis is to form a recommended "To Be" architecture. The "To Be" environment is a projection for the years 1996 to 2002. Presently, systems and Concept of Operations (CONOPS) are already under development for this environment. Therefore, the analysis provides insight into the ability of the proposed systems and CONOPS to support the Marine Corps' objective of seamlessly integrating the TBMD architecture into the MAGTF C4I Architecture and providing effective and efficient missile defense.

B. INTELLIGENCE DATA FLOW

Intelligence Data Flow is the ability to input, receive, process (fuse and correlate), store, display, and disseminate intelligence data on Tactical Ballistic Missile (TBM) operations to permit friendly counter-operations, maneuver, and resource allocation within the enemy's decision and action cycle [Ref. 9]. This analysis provides information that will allow answers to be developed concerning the flows between systems and their disconnects. Specifically, the ability of the information architecture to provide the following:

1. Information

This analysis does not concentrate entirely on the type of information received by C2 Facilities. More effort is spent examining how and in what form the information is received. Questions such as, "Is the system capable of properly communicating information?" and "Are there problems within the system that hinder information flow?", are used as the basis for the analysis. Specific matrices explore different aspects of these questions.

- Matrix 2, INTELLIGENCE TO ACTIVITY, demonstrates the level of intelligence used by the C2 Facilities in the TBMD system.
- Matrix 7, INTELLIGENCE TO EQUIPMENT, examines the possible dilemmas in information flow within the TBMD system. The areas of concern are efficiency, formatting, processing, and decision making.

- Matrix 9, OUTPUTS TO C2 FACILITY, demonstrates the level of information that flows into, and out of, C2 Facilities. The matrix also addresses the concern of timely, accurate communications between C2 Facilities.

- Matrix 11, EQUIPMENT TO TACC-COMM TYPE-TAOC, demonstrates the problems of communication (i.e., timeliness, efficiency, and information accuracy) in a inter-facility environment.

- Matrix 12, EQUIPMENT TO TAOC-COMM TYPE-BCP, mirrors Matrix 11, but at the TAOC to BCP level.

- Matrix 13, INTELLIGENCE TO TACC-EQUIPMENT-TAOC, examines how information and its effects on decision making in a inter-facility environment.

- Matrix 14, INTELLIGENCE TO TAOC-EQUIPMENT-BCP, mirrors Matrix 13, but at the TAOC to BCP level.

Each matrix tells a portion of the overall story concerning how and in what form information is received. It is not until the information in the matrices is combined that a complete picture can be presented. The matrices help identify that there is a problem with the format in which information is received. Matrix 7, combined with Matrix 3 and Matrix 6, illustrates the problem. The matrices show that information (IPBDB Info) received by the TAOC (SAAWC) can be received with five separate pieces of equipment. The matrices also show that the information, once received, can be displayed on five different pieces of equipment. Furthermore, the matrices indicate that information then has to be processed (correlated) and transmitted out of the TAOC (SAAWC) on one of three possible systems. The choice of what system is used is determined by which C2 Facility the information is received from and which C2 Facility the processed information is going to. The entire system does not lend itself to effective information flow into or out of the C2 Facility.

Another example is presented by Matrix 13. When the information from this matrix is combined with information from Matrix 3, Matrix 4, and Matrix 7, an information flow problem is identified. In the example, Threat Capabilities are transmitted from the TACC to the TAOC. The TAOC processes the information and transmits it out to other C2

Facilities. The matrices identify the equipment that can be used to transmit, receive, process, and display the information. Even under perfect conditions, using the LAN/WAN to communicate intelligence, the TACC and TAOC still encounter problems displaying the information received. The flow of information is interrupted because information has to be displayed by a separate type of equipment. The use of the LAN/WAN is a best case scenario, if another type of equipment is substituted to facilitate communications, the results would be even further compounded.

2. C2 Facility

The analysis concentrates on the flow of intelligence to the C2 Facilities. Areas of interest are: how information is communicated to the C2 Facilities, how information is used by the C2 Facilities once it is received, and how information is handled once it is received by a C2 Facility. Questions like, "In terms of information flow, what capabilities does a C2 Facility have?" and "Are C2 Facilities receiving the information they need to complete the mission?", are used to assist in the analysis. Specific matrices explore different aspects of these questions.

- Matrix 1, C2 FACILITY TO ACTIVITY, indicates the level of involvement of C2 Facilities throughout the TBMD process.

- Matrix 2, INTELLIGENCE TO C2 FACILITY, indicates the level of intelligence used throughout the TBMD process. Combined with Matrix 2, it demonstrates the level of intelligence used by the C2 Facilities in the TBMD system.

- Matrix 3, EQUIPMENT TO C2 FACILITY, demonstrates the ability of the C2 Facility to receive, transmit, process, display or do all of the above, in terms of capabilities.

- Matrix 6, INTELLIGENCE TO C2 FACILITY, indicates the amount of intelligence the C2 Facility will handle in carrying out its mission. Also, demonstrates the capabilities of the C2 Facility concerning information flow.

- Matrix 9, OUTPUTS TO C2 FACILITY, when combined with Matrix 1, reenforces the idea of a high level of information flow to and from the C2

Facilities. The matrix also indicates the importance of effective communication between C2 Facilities.

- Matrix 11, EQUIPMENT TO TACC-COMM TYPE-TAOC, demonstrates the ability of the C2 Facility to receive, transmit, process, display or all of the above on a specific level.

- Matrix 12, EQUIPMENT TO TAOC-COMM TYPE-BCP, mirrors Matrix 11 at the TAOC to BCP level.

- Matrix 13, INTELLIGENCE TO TACC-EQUIPMENT-TAOC, indicates which C2 Facility, specifically the TACC or TAOC, uses what intelligence. The matrix also examines the C2 Facility's capability in handling information at that specific level.

- Matrix 14, INTELLIGENCE TO TACC-EQUIPMENT-BCP, mirrors Matrix 13 at the TAOC to BCP level.

Each matrix tells a portion of the overall story concerning how information is communicated to and used by C2 Facilities. It is not until the matrices are combined that a complete picture can be presented. The matrices aid in the identification of a problem with how the information is received and in what format the information is received. The matrices do not identify any direct problems associated with C2 Facilities' capabilities. However, the matrices do indicate that the problems with receiving information at C2 Facilities were equipment related. These problems, in turn, do affect the use of the information received.

As discussed earlier, the C2 Facilities have difficulty handling information because the different types of equipment employed at each facility dictate how and in what format the information is received. This, in turn, leads to problems of information incompatibilities. Information received in one format could not be easily correlated with information of another format. This, in turn, hindered effective communication because valuable time is lost in displaying and processing the information. Matrix 3, combined with Matrix 9, illustrates an example of this problem.

From Matrix 9, Target Information is transmitted by both the TAOC (SWD) and the TAOC(SAAWC). That information is received, displayed and processed by the ACE Battlestaff (COS) and the HAWK (TCO). The HAWK (TCO) also transmits Target Information to the ACE Battlestaff (COS). From Matrix 3, The TAOC (SWD and SAAWC) can transmit the information, in this case, using three different pieces of equipment. However, within the HAWK (TCO) and the ACE Battlestaff (COS) only one of those three types of equipment can process the information once it is received. More importantly, none of the three pieces of equipment in the HAWK (TCO) or ACE Battlestaff (COS) can display the information. It has to be done manually. The same scenario is apparent when viewing information passed between the HAWK (TCO) and the ACE Battlestaff (COS). This is a clear indication of inefficient communications. Time is wasted manually converting information for display purposes. Also, depending on the equipment used, there is wasted processing time associated with the use of different types of equipment.

3. Equipment

This analysis focuses on the equipment's capability in terms of information flow. The main concern of this analysis is equipment adequacy. Questions like, "Does the equipment perform the necessary functions for the C2 Facility to operate?" and "What effect does equipment have on information flow?", are used as a foundation on which to build the analysis. Specific matrices explore different aspects of these questions.

- Matrix 3, EQUIPMENT TO C2 FACILITY, indicates how the equipment is used to handle information within the C2 Facility.
- Matrix 7, INTELLIGENCE TO EQUIPMENT, demonstrates dilemmas associated with equipment and information flow (i.e., efficiency problems, processing problems, and decision making problems).
- Matrix 10, OUTPUTS TO EQUIPMENT, demonstrates the problems that may arise when communicating information over more than one type of equipment (i.e., time consuming and ineffectiveness).

- Matrix 13, INTELLIGENCE TO TACC-EQUIPMENT-TAOC, indicates whether equipment supports the mission of the C2 Facility, in the context of the TACC and the TAOC.

- Matrix 14, INTELLIGENCE TO TAOC-EQUIPMENT-BCP, mirrors Matrix 13 at the TAOC to BCP level.

Each matrix tells a portion of the overall story concerning equipment adequacy. It is not until the matrices are combined that a complete picture can be presented. The matrices assist the identification of problems with the equipment. The problem is communicating information over different types of equipment. This has previously been identified and documented when addressing the C2 Facilities. However, what was not discussed was the equipment's capabilities. Matrix 13 explores the question and sheds some light on equipment capabilities. The analysis provided in Matrix 13 also raises the issue of underutilized equipment.

Matrix 13, along with information from Matrix 3, establishes that the TACC has within its boundaries the entire ACE Battlestaff, the JFC (Political Advisor), the JTF Commander, and the ACE Commander. With these commands come almost every piece of communications equipment in the TBMD architecture. However, these systems are not being used to their fullest advantage. The same can be said for the TAOC. Even though the SAAWC is the only command within the TAOC receiving Report (ESM) information from the TACC, it is not using its TADIL capabilities to their fullest extent. Both of these examples demonstrate the lack of cohesion between C2 Facilities necessary to communicate information in a timely, efficient, adequate manner.

4. Usefulness

This analysis concentrates on what happens to information once a C2 Facility receives it. This focuses on information adequacy and the effects of poor communication. Questions such as, "Is information being received in a useable format?", "Is multi-intelligence data being processed in a timely manner?" and "What happens to information once it is received?", are used to facilitate the analysis. Specific matrices explore different aspects of these questions.

- Matrix 6, INTELLIGENCE TO C2 FACILITY, demonstrates how C2 Facilities are using intelligence once it is received.

- Matrix 7, INTELLIGENCE TO EQUIPMENT, indicates the format information is received in and its usefulness.

- Matrix 9, OUTPUTS TO C2 FACILITY, demonstrates how information is used once it is received.

- Matrix 13, INTELLIGENCE TO TACC-EQUIPMENT-TACC, indicates a problem with receiving information in a timely manner at the TACC to TAOC level and with correlation of said information once it is received. This matrix also examines whether or not information received is in a format favorable to effective decision making.

- Matrix 14, INTELLIGENCE TO TAOC-EQUIPMENT-BCP, mirrors Matrix 13 at the TAOC to BCP level.

Each matrix tells a portion of the overall story concerning what happens to information once it is received. It is not until the matrices are combined that a complete picture can be presented. The matrices help to identify the problem with information adequacy. The problem, however, does not lie with information. On the contrary, as established in the examination of C2 Facility, the problem is associated with the equipment types used to communicate information. This fact is well established and was documented also in the equipment analysis. Matrix 14, combined with information contained in Matrix 3, Matrix 4, and Matrix 7, illustrates another example of the problem.

Threat Capabilities, is transmitted by the TAOC and received by the BCP. It is also apparent (because the pieces of equipment are present at both facilities) that the information will be transmitted and received by one of three pieces of equipment, LAN/WAN, Tactical Modem or Tactical Radio. In this instance the best choice is the LAN/WAN because of its capabilities. Now, Matrix 3, shows that the HAWK (TCO), which is the C2 Facility for the BCP, only receives, transmits and processes information via the LAN/WAN. This means that the LAN/WAN, even though it is capable, cannot be used to display the intelligence in

the BCP. The only display capability at the BCP is through equipment inherent to the BCP or through manual means. This illustrates the problem of a C2 Facility forced to spend time manually displaying information because the equipment's inability to communicate information in a useful format and with an infrastructure that allows a variety of different hardware to integrate the flow and use of data.

C. BATTLE MANAGEMENT INFORMATION ARCHITECTURE COHESIVENESS

Battle Management Information Architecture Cohesiveness is the ability of the decision maker to receive the appropriate information, in time to act on it, and in the format required for understanding. More specifically, the analysis concentrates on the flow of information to and from the C2 Facilities and how it affects their performance. The analysis will explore:

1. Timeliness

This analysis concentrates on the timeliness in which information is transmitted or received. The key point is whether the information is received in a timely manner. The question, "Is the information communicated in a timely manner?", is used as a building block for the analysis. Specific matrices explore different aspects of these question. For example:

- Matrix 2, INTELLIGENCE TO ACTIVITY, is the first indicator that there may be a problem receiving information in a timely manner.
- Matrix 3, EQUIPMENT TO C2 FACILITY, indicates that timeliness may be a problem when receiving information.
- Matrix 6, INTELLIGENCE TO C2 FACILITY, reenforces the importance of information within the C2 Facilities. The matrix also reiterates the idea of timely, accurate communication between C2 Facilities.
- Matrix 9, OUTPUTS TO C2 FACILITY, addresses the concern of timely, accurate communications between C2 Facilities.
- Matrix 10, OUTPUTS TO EQUIPMENT, indicates the problem of timeliness due to communications over multiple types of equipment.

- Matrix 11, EQUIPMENT TO TACC-COMM TYPE-TAOC, demonstrates the problems of communication (i.e., timeliness, efficiency, and information accuracy) in a inter-facility environment.

- Matrix 12, EQUIPMENT TO TAOC-COMM TYPE-BCP, mirrors Matrix 11, but at the TAOC to BCP level.

Each matrix tells a portion of the overall story concerning what happens to information once it is received. It is not until the matrices are combined that a complete picture can be presented. The matrices help to identify the problem of getting information to the C2 Facility in a timely fashion. Almost every matrix portrays the message of the importance of timely information flows to aid in decision making and efficient communications. However, the best and most concise example is illustrated in Matrix 9.

Matrix 9 indicates that Target Information is transmitted by both the TAOC (SWD) and the TAOC(SAAWC). That information is received, displayed and processed by the ACE Battlestaff (COS) and the HAWK (TCO). The HAWK (TCO) also transmits Target Information to the ACE Battlestaff (COS). The TAOC transmits Target Information to the HAWK Battalion which receives, displays and processes the information. The HAWK Battalion, once they have correlated the data, then transmits their Target Information to the ACE Battlestaff. The ACE Battlestaff receives the Target Information from both the TAOC and the HAWK Battalion and uses the information to monitor the situation. In this instance, the HAWK (TCO) cannot react to a track very well if the TAOC does not identify, to them, the presence of a possible target and the classification of the target. This demonstrates the need for timely, accurate communications between C2 Facilities. This is also a prime example of the importance of information flow within the TBMD system.

2. Format

This analysis focuses on the receipt format. The area of interest is whether the C2 Facility's decision making ability is assisted or impeded by the information it receives. The question, "Is the information received in a correct and useable format?", is used as an

example of topics on which the analysis should concentrate. Specific matrices explore different aspects of these question.

- Matrix 7, INTELLIGENCE TO EQUIPMENT, demonstrates the format information is received in and its usefulness.
- Matrix 10, OUTPUTS TO EQUIPMENT, addresses the problems associated with communicating via several types of equipment, in terms of format.
- Matrix 11, EQUIPMENT TO TACC-COMM TYPE-TAOC, demonstrates the format problems associated with communicating information in a inter-facility environment.
- Matrix 12, EQUIPMENT TO TAOC-COMM TYPE-BCP, mirrors Matrix 11, but at the TAOC to BCP level.
- Matrix 13, INTELLIGENCE TO TACC-EQUIPMENT-TACC, indicates a problem with receiving information in a timely manner at the TACC to TAOC level and with correlation of said information once it is received. This matrix also examines whether or not information received is in a format conducive to effective decision making.
- Matrix 14, INTELLIGENCE TO TAOC-EQUIPMENT-BCP, mirrors Matrix 13 at the TAOC to BCP level.

Each matrix tells a portion of the overall story concerning what happens to information once it is received. It is not until the matrices are combined that a complete picture can be presented. The matrices aid in the identification of the problems associated with receiving information in the wrong (wrong being defined as not readily adaptable to a type of equipment for the purpose of processing, displaying, or transmitting) format and how it affects decision making. Matrix 12, combined with information contained in Matrix 3, Matrix 4, Matrix 6, Matrix 7, and Matrix 11, illustrates the importance of receiving information in the correct format. The matrix also amplifies the problems associated with receiving information in the wrong format.

Matrix 12 demonstrates that Track (AN/TPS-59 Data) intelligence can be received by the BCP from four separate TAOC commands, over five separate pieces of equipment.

Over those four pieces of equipment, it is possible that the information could be received using one of two communication types. Track (AN/TPS-59 Data) information, being transmitted in five different formats, using two communication types and being displayed on three possible mediums, has to be correlated and processed. If that were not enough, the processed information has to be broken down (transformed) and transmitted out of the BCP to the proper C2 Facilities in the appropriate format. This is a representation of formatting problems leading to efficiency problems, formatting problems, processing problems, and ultimately, decision making problems.

3. Adequacy

This analysis concentrates on information adequacy in terms of decision making capabilities. The focus here is in determining if the C2 Facilities are receiving information in a format adequate for making decisions. The question, "Does the format and timeliness of information effect its adequacy?", is a starting point for the analysis. Specific matrices explore different aspects of these question.

- Matrix 3, EQUIPMENT TO C2 FACILITY, indicates that timeliness may be a problem when receiving information. It also indicates a problem with the communications system in the decision making process.

- Matrix 7, INTELLIGENCE TO EQUIPMENT, demonstrates the format information is received in and its usefulness. Also, indicates problems associated with decision making.

- Matrix 9, OUTPUTS TO C2 FACILITY, addresses the concern of timely, accurate communications between C2 Facilities.

- Matrix 10, OUTPUTS TO EQUIPMENT, indicates the problem of timeliness due to communications over multiple types of equipment and its effect on decision making.

- Matrix 11, EQUIPMENT TO TACC-COMM TYPE-TAOC, demonstrates the format problems associated with communicating information in an inter-facility environment. It also demonstrates the effects of format problems on information adequacy and on the decision making process.

- Matrix 12, EQUIPMENT TO TAOC-COMM TYPE-BCP, mirrors Matrix 11, but at the TAOC to BCP level.
- Matrix 13, INTELLIGENCE TO TACC-EQUIPMENT-TACC, indicates a problem with receiving information in a timely manner at the TACC to TAOC level and with correlation of said information once it is received. This matrix also examines whether or not information received is in a format conducive to effective decision making.
- Matrix 14, INTELLIGENCE TO TAOC-EQUIPMENT-BCP, mirrors Matrix 13 at the TAOC to BCP level.

Each matrix tells a portion of the overall story concerning what happens to information once it is received. It is not until the matrices are combined that a complete picture can be presented. The matrices help to identify if the information received is adequate enough to make mission critical decisions. Adequacy, in this sense, refers to the timeliness and format of the information received. Both timeliness and format have been addressed previously. It is apparent from the analysis previously conducted that the information being received by the C2 Facilities is not adequate in terms of efficient decision making. This conclusion is best illustrated by Matrix 11, matrix 12, matrix 13, and matrix 42. All four matrices examine the flow of information, equipment, and their effect on the decision making process in terms of timeliness, efficiency, and adequacy.

D. BATTLE MANAGEMENT INFORMATION SUPPORT

Battle Management Information Support is the ability to process, build, and maintain a situation display based on track data and point data received from local and remote sensors over data links from other agencies. Also, it is the TBMD system's ability to distribute the data required by the launchers and other appropriate C2 Facilities. More specifically, it is the ability of equipment to provide the following:

1. Mission Support

This analysis concentrates on the equipment's support of the mission. The focus is on whether equipment, located in the C2 Facilities, expedites or impedes the decision making process. The questions, "Is information communicated effectively to and from C2

Facilities?" and "Does equipment provide the capabilities necessary to support the decision making process?", are used as the basis for this analysis. Specific matrices explore different aspects of these question.

- Matrix 3, EQUIPMENT TO C2 FACILITY, indicates that timeliness may be a problem when receiving information. It also indicates a problem with the communications system in the decision making process.

- Matrix 7, INTELLIGENCE TO EQUIPMENT, demonstrates the format in which information is received and its usefulness. Also, indicates problems associated with decision making.

- Matrix 10, OUTPUTS TO EQUIPMENT, indicates the problem of timeliness due to communications over multiple types of equipment and its effect on decision making.

- Matrix 11, EQUIPMENT TO TACC-COMM TYPE-TAOC, demonstrates format problems associated with communicating information in a inter-facility environment. Also demonstrates the effects of format problems on information adequacy and on the decision making process.

- Matrix 12, EQUIPMENT TO TAOC-COMM TYPE-BCP, mirrors Matrix 11 at the TAOC to BCP level.

- Matrix 13, INTELLIGENCE TO TACC-EQUIPMENT-TAOC, indicates a problem with receiving information in a timely manner at the TACC to TAOC level and with correlation of said information once it is received. This matrix also examines whether or not information received is in a format conducive to effective decision making.

- Matrix 14, INTELLIGENCE TO TAOC-EQUIPMENT-BCP, mirrors Matrix 14 at the TAOC to BCP level.

Each matrix tells a portion of the overall story concerning what happens to information once it is received. It is not until the matrices are combined that a complete picture can be presented. The matrices aid in the identification the problem of equipment impeding decision making and, thereby, impairing mission support. Matrix 7, combined with information from Matrix 3 and Matrix 6, is a prime example of the problem. Matrix 7

demonstrates that IPBDB Info is received by the TAOC (SAAWC) from a possible seven separate C2 Facilities, over five separate pieces of equipment. This information, in five different formats and being displayed on five separate mediums, has to be correlated and processed. If that is not enough, then the processed information has to be broken down and transmitted out of the TAOC (SAAWC) to the proper C2 Facilities in the appropriate format. This is a representation of efficiency problems, formatting problems, processing problems, and ultimately, decision making problems.

2. Adequate Capabilities

This analysis concentrates on the equipment used within the TBMD system. The focus is centered around the equipment's abilities. Questions like, "Is there system redundancy?" and "Are there too many different types of equipment being used?", aid in the analysis.

Specific matrices explore different aspects of these question.

- Matrix 3, EQUIPMENT TO C2 FACILITY, indicates the capabilities of the equipment within the C2 Facilities. The matrix also explores the possibility of system redundancy.

- Matrix 4, EQUIPMENT TO COMMUNICATION TYPE, depicts the different classes of communication utilized by the different types of equipment. The matrix also examines equipment redundancy.

- Matrix 5, COMMUNICATION TYPE TO C2 FACILITY, depicts the different classes of communication used by C2 Facilities. It also supports the idea of system redundancy.

- Matrix 7, INTELLIGENCE TO EQUIPMENT, demonstrates the redundancy of equipment and the associated problems affecting the flow of information. The matrix also demonstrates the need to minimize the amount of equipment employed in the TBMD system.

- Matrix 8, INTELLIGENCE TO COMMUNICATION TYPE, demonstrates the different classes of communication associated with intelligence. The matrix also examines the existence of equipment redundancy. Finally, the matrix demonstrates the need to reduce the number of equipment types.

- Matrix 10, OUTPUTS TO EQUIPMENT, demonstrates the existence of equipment redundancy. The matrix also examines the problems associated with communicating information over more than one type of equipment.

- Matrix 11, EQUIPMENT TO TACC-COMM TYPE-TAOC, demonstrates the communication problems associated with equipment. The matrix also indicate the presence of equipment redundancy within the C2 Facilities. The matrix, further, examines the issue of not exploiting equipments full capabilities.

- Matrix 12, EQUIPMENT TO TAOC-COMM TYPE-BCP, mirrors Matrix 11 at the TAOC to BCP level.

- Matrix 13, INTELLIGENCE TO TACC-EQUIPMENT-TAOC, demonstrates the equipment's ability to support the mission. The matrix also examines the issue of equipment capabilities not being available at all C2 Facilities.

- Matrix 14, INTELLIGENCE TO TAOC-EQUIPMENT-BCP, mirrors Matrix 13 at the TAOC to BCP level.

Each matrix tells a portion of the overall story concerning what happens to information once it is received. It is not until the matrices are combined that a complete picture can be presented. The matrices help to identify problems with the communications equipment used in the TBMD system. There are problems of equipment redundancy in the TBMD system, equipment capabilities not being exploited by C2 facilities, and excessive types of equipment were employed within C2 Facilities. Matrix 13, combined with information contained in Matrix 3 and Matrix 6, best illustrates the problems of system redundancy and excessive types of equipment being deployed at C2 Facilities. The matrix shows that Report (ESM) data is transmitted to the TACC from five different C2 facilities, over three possible types of equipment. The matrix then indicates that information is processed and displayed, in almost all instances, by different types of equipment within the TACC. The matrix goes on to show that different commands, within the TACC, process and display the Report (ESM) data on one of four different types of equipment. Next, the matrix examines the role of the TAOC. The matrix shows that once information is processed (correlated and or fused) at the TACC, it is transmitted to the TAOC via one of three types of equipment.

Finally, the matrix indicates that the information, at the TAOC, is also displayed and processed on one of seven different types of equipment.

However, this is not all that the matrix illustrates. The matrix also examines the problem of equipment capabilities not being totally exploited by C2 Facilities. Matrix 13 explains that the TACC has within its boundaries the entire ACE Battlestaff, the JFC (Political Advisor), the JTF Commander, and the ACE Commander. With these commands, come almost every piece of communications equipment in the TBMD architecture. However, these systems are not being used to their fullest advantage. Different types of equipment possess different capabilities within the confines of their respective C2 Facilities. For example, the ACE Battlestaff (COS) has TADIL A and TADIL B equipment, but the capabilities are limited to display and process only. The same holds true for the TAOC. Even though the SAAWC is the only command within the TAOC receiving Report (ESM) information from the TACC, it is not using its TADIL A and TADIL B capabilities to their fullest extent.

E. CONCLUSION

The current Marine Corps "As Is" TBMD architecture was developed to meet the need for Theater Missile Defense (TMD) identified during the Persian Gulf War. It was crucial to establish an architecture that would deal with the problems associated with MAGTF operation against an enemy with Theater Missile capabilities. Once an initial system was in place, opportunity existed to go back and refine the system to meet the needs of the Marine Corps. However, first, a TBMD system had to be in place, even if it meant initializing a system that was inadequate.

The first phase of the analysis examines the "As Is" TBMD architecture and identifies its strengths and weaknesses. Its strengths lie in the foundation of the HAWK Missile System. However, the main concern of this analysis is to identify the weaknesses of the architecture as they relate to Intelligence Data Flow, Battle Management Information Architecture Cohesiveness, and Battle Management Information Support.

The "As Is" model displays a unique configuration of communications types that link many different components. Within the entire process of identifying, tracking, and launching, there is no "one" function that is more critical than any other function. All the components have to be involved for a missile shoot to be successful. The problem is that although the entities are connected and have communications capabilities, those capabilities are often times inadequate. The first deficiency is that most of the communications equipment located in the C2 Facilities is not being fully exploited. The capabilities available with each type of equipment are not being utilized to their fullest potential. Information is not getting to the people that need it to make decisions in a timely, efficient manner. The second deficiency is that the information being passed between the entities does not enable quick decision making. An aircraft tracking an inbound ABT on its display must radio that information to the TAOC. The TAOC, who receives the information manually (voice to written), must then check the information against the AN/TPS-59, CWAR or PAR radar displays to ensure the track is being picked up. Then the information must be converted again (manually) before it can be radioed to the BCP. This process, often times more intricate, is repeated over and over for each different track. The final deficiency is that the information, once received, is not in the correct format. An example would be the TAOC receiving a combination of digital radar displays, voice communications from aircraft, and internally generated manual reports and then trying to correlate the information to make a launch decision. The Marine Corps found out during the Persian Gulf War that this process took too much time. A solution is needed that will allow for the timely transmission of correlated information in a usable format.

The second phase of the analysis is two-fold. First, make a recommendation for a Marine Corps "To Be" TBMD architecture. The proposed "To Be" architecture is contained in Appendix F. Recommended changes to the physical environment of the "As Is" architecture are not drastic. However, some recommendations that are not addressed in Appendix F are: improvement of existing systems capabilities within the C2 Facilities to facilitate efficient communications throughout the TBMD environment and the reduction of the number of redundant system within the TBMD arena.

Second, examine the systems already under development for the "To Be" environment and address their ability to support the Marine Corps' objective of seamlessly integrating the TBMD architecture into the MAGTF C4I Architecture and providing effective and efficient missile defense. Some of the systems under development, that will be addressed in Chapter IV, are: the development of an Air Defense Communications Platform (ADCP) to facilitate communications and information flow between the TAOC and the BCP, the development of a Sector Anti-Air Warfare Coordination (SAAWC) Operations Facility (SOF) to be located within the TAOC, the development of the Tactical Digital Information Link J (TADIL J) to facilitate communications internally and externally within the TBMD environment, improvements to the AN/TPS-59 radar to enable a wider coverage of the MAGTF's area of responsibility, and improvements in the capabilities of the HAWK Missile system to include Ballistic Missile Defense.

The key to the analysis of the Marine Corps TBMD Architecture is to remember that the physical environment of the architecture is very dynamic and suggested changes to that physical environment or in a particular technology are forecasts of what that future might bring. In the context of TBMD, nothing is certain. As this is written, the possibility exists that the Marine Corps' role in TMD could be diminished drastically [Ref. 9].

IV. INITIATIVES AND EMERGING TECHNOLOGIES

A. INTRODUCTION

As identified in Chapter III, there are opportunities for improvement in the Marine Corps "As Is" TBMD model in the following areas: Intelligence Data Flow, Battle Management Information Architecture Cohesiveness, and Battle Management Information Support. The Marine Corps has undertaken several initiatives to enhance the structure of the "As Is" TBMD environment. This chapter examines those initiatives, their capabilities, and their ability to alleviate the deficiencies identified in Chapter III. The initiatives examined fall into three separate categories. First, there are improvements to the HAWK Missile System and the AN/TPS-59 Radar. These are improvements to existing technology. The development of these two system enhancements address problems associated with communications and interoperability. Their implementation has little effect on the physical makeup of the TBMD architecture. Second, there are enhancements to the Tactical Air Operations Center (TAOC) and the Battery Command Post (BCP). These are additions to the existing physical architecture. These changes address the communications and information flow. Also, these changes will have a direct effect on how the proposed "To Be" TBMD architecture will be laid out. Finally, there is the acquisition of the Tactical Digital Information Link J (TADIL J). This is a new technology. The system, TADIL J, directly addresses the problems associated with communications (i.e., timeliness, efficiency, and decision making abilities). This technology also has a significant effect on the physical layout of the Marine Corps "As Is" TBMD architecture (Appendix F, Figure F.1).

B. USMC TBMD SYSTEM WITH HAWK AND AN/TPS-59 IMPROVEMENTS

The USMC TBMD system has evolved from the Marine Corps' existing TAOC/SAAWC, AN/TPS-59, and USMC HAWK Missile System. Upgrades to the HAWK Missile environment will provide the Marine Corps with short-range ballistic missile (SRBM) capabilities and limited medium-range ballistic missile (MRBM) capabilities. The TBMD environment will retain its inherent capabilities to integrate an array of air defense

systems designed to counter air breathing targets (ABTs) and cruise missiles. The nonorganic sensors and processors will also retain its ability to detect and track long-range missiles. The TMD system will interoperate with THAAD, PATRIOT, and Navy TBMD systems as a part of an integrated TMD family of systems (FOS).

1. High Altitude Will Kill (HAWK) Missile System

The HAWK Missile System is a mobile, surface-to-air guided missile, air defense system that plays a key role in defending Marine Expeditionary Forces (MEFs) during amphibious assaults, forced entry operations, and other assigned missions. The HAWK system can operate as a stand-alone system or can be integrated with other existing air defenses systems such as the Army's PATRIOT or the Navy's AEGIS Standard Missile-2 (SM-2).

Salient HAWK features are 360 degree surveillance, interceptor guidance by a separate fire control radar (FCR), and the ability to engage multiple targets with or without human control. The HAWK Launcher contains three HAWK missiles and can be located remotely from the radar and other equipment. The HAWK system has been repeatedly upgraded to defeat increasingly sophisticated threats and is programmed for additional upgrades so that it can remain a contributing participant in TMD operations.

Planned improvements that will enhance TMD effectiveness include the following:

- Converting to a digital interface between the launcher and missile.
- Upgrading the launcher train and elevation mechanism to reduce the precommit timeline.
- Improving the launcher to allow movement with full weapons load (three ready-to-fire HAWK missiles or up to eight alternative missile types).
- Reducing set-up and tear-down times.
- Improving the missile warhead to increase lethality against TBMs.
- Adding the Air Defense Communications Platform.

Other enhancements under consideration include incorporating BCP functions into the ADCP and adding TBMD C3I functions to the TAOC (TAOM). Also, communication enhancements include early warning enhancements to the theater and the joint data network capabilities and initial capabilities of the joint fire control network to the theater and joint data network. These enhancements increase communications and provide improved early warning to theater, joint data networks, and the joint fire control network.

2. AN/TPS-59 Radar

The An/TPS-59 is a solid-state radar with a phased array antenna. The antenna electronically scans in elevation while continuously rotating in azimuth to provide real-time three dimensional data on all objects within the specified surveillance volume and time frame. The radar provides a maximum surveillance volume of 4 to 30 nautical miles in range, 0 to 19 degrees in elevation, 100,000 feet in altitude, and 360 degrees in azimuth. The radar's operating frequency is in the 1215 to 1400 megahertz frequency (L-band). It provides air breathing target (ABT) and theater ballistic missile (TBM) target cueing data to HAWK, other theater sensors, and weapon systems, but is not currently designed to accept cueing.

The AN/TPS-59 radar is being upgraded to provide long-range, high-altitude surveillance and tracking of TBMs. The AN/TPS-59 will provide target cueing data to HAWK and other theater sensors and weapons systems and will be modified to accept cueing. Planned enhancements to the AN/TPS-59 radar will improve range performance with small targets, increase data processing speed and capacity, and provide direct communication links with other sensors and theater dat networks. The surveillance volume for TBMs will increase 400 nautical miles, with an elevation of 70 degrees and an altitude in excess of 500,000 feet. Beyond the year 2002, the AN/TPS-59 radar will have additional incremental improvement of its capability.

C. INITIATIVES

There are two changes to the "As Is" physical architecture that are currently being undertaken. First, the BCP will no longer be directly linked to the TAOC. Communications

will be facilitated through an Air Defense Communication Platform (ADCP). The next change will occur within the TAOC. A Sector Anti-Air Warfare Coordination Operations Facility (SOF) will be located within the TAOC. The SOF will be linked, via a LAN, to the TAOM and the Operations Center. These two enhancements are designed to improve communications within the architecture and allow for better command and control.

1. Air Defense Communications Platform (ADCP)

The ADCP was added to facilitate communications between the TAOC and the BCP. The ADCP will receive TBM tracks from AN/TPS-59 radars, to filter geographically any TBM data of interest to HAWK Batteries, to propagate TBM tracks in time and space, to perform coordinate conversion and data formatting functions, to provide connectivity to the joint data network, and to provide communications throughout TMD's identify, track, and launch process. In operation, the AN/TPS-59 radars and the theater joint data network forward TBM tracks to the battery ADCP, which correlates and forwards these tracks to the BCP, the platoon-level command, control, coordination, and intelligence (C3I), and fire control center.

The ADCP will be the first Marine Corps program to have JTIDS/TADIL J capability. This capability is intentionally limited to Network Management, Precise Participant Location and Identification (PPLI), and three Theater Missile Defense (TMD) messages. The ADCP is planned as an interim JTIDS/TADIL J participant until the TAOC has this capability.

2. Sector Anti-Air Warfare Coordinator (SAAWC) Operations Facility (SOF)

The SOF, located in the TAOC, houses the SAAWC and SAAWC staff, who supervise anti-air warfare (AAW) operations. The SAAWC is the ACE Commander's air defense battle manager. The SAAWC's principle function is that of tactical decision making. The SAAWC should be activated whenever there is a need for timely, adroit orchestration of the interaction of surface-to-air and air-to-air defense assets for both MAGTF and Joint Operations. When established, the SAAWC becomes the representative of the Tactical Air Commander (TAC) at the TAOC [Ref. 4].

The SAAWC is responsible to the TAC for:

- During the planning process:

  * Provide qualified representation to the Air Combat Element (ACE) Battlestaff to develop appropriate courses of action based on the perceived threat

  * Recommend tactical placement of command and control assets to best counter the threat

  * Develop, in conjunction with surface-to-air weapons representatives, appropriate states of alert and airspace control measures to maximize their effectiveness

  * Plan the communication need-lines of the TAOC to cover the Alternative TACC Functions

- During the execution phase:

  * Decentralized management of assigned weapons platforms

  * Coordination of all active and passive air defense and air traffic within an assigned sector under the direction of higher authority

  * Maintaining the status of committed assets and resources for the TACC

  * Recommending adjustments to the states of alert for; Radiation Control (RADCON), Emissions Control (EMCON) Conditions, and Weapons Release Conditions to the TAC as appropriate

  * Coordinating with adjacent agencies

  * Recommending changes in airspace control measures to the TAC

  * Determination of the deployment and commit criteria for available assets in coordination with the TAC

* Based on the recognized air picture, plan tactics 15 to 60 minutes ahead of the real-time battle

* Be prepared to assume the role of the Alternate TACC should the TACC become a casualty

D. COMMUNICATIONS

After the Persian Gulf War, the Navy and the Marine Corps knew that the the SCUD missile, or proposed missile, attacks created a crisis they were not equipped to deal with. Poor communications techniques and faulty information flow could have resulted in a crushing blow to the Navy and Marine combined missile defense efforts. These problems have since been identified and resources are being expended to develop a more effective system. The problems have also been examined in the analysis presented in Chapter III and further amplify the communications issue. TADIL J, by itself, is not the panacea to the problems that exist. However, it, coupled with other advances, definitely aids in alleviating the current communications problems.

1. Tactical Digital Information Link J (TADIL J/Link 16)

Link 16/TADIL J is a part of a joint service system known as Joint Tactical Information Distribution System (JTIDS). JTIDS is interoperable with USN/USAF/USA/ USMC/United Kingdom/France and NATO terminals. Link 16 will become an important netted data link between most TMD platforms, other forces, and allies by the year 2002. It promises to provide increased throughput, security, jam resistance, grid accuracy, and interoperability. Link 16 is the U.S. Naval/North Atlantic Treaty Organization (NATO) terminology for sets of netted links which allow for the exchange of tactical information among ships and aircraft in digital format in accordance with protocols and standards set forth in Navy Operational Specification 516 and NATO's STANAG 5516. Link 16 message standards and protocols are being modified to handle the TBMD requirements. Other system improvements will be made after Link 16 is introduced during the mid 1990s, but the first major upgrade will be the Enhanced Link 16 in the 2010 time frame.

JTIDS is a Time Division Multiple Access (TDMA), jam resistant, digital data, and voice communication system operating in the 960-1215 MHZ frequency range with gaps for Tactical Air Navigation Beacon (TACAN) and Identification Friend or Foe (IFF). Service on JTIDS can be broadcast or link specific. There are three modes by which users can access a net: Dedicated (preassigned), Contention, and Time Slot Reallocation. There are also two relaying modes Paired Slot and Repromulagation [Refs. 2, 3, and 11]. JTIDS supports a number of information transfer requirements for TMD.

- Track data on target position, position uncertainty, velocity, and velocity uncertainty.
- Launch point estimation.
- Impact point and time of arrival.
- Warhead type and type confidence.
- Launcher locations.
- Track status.
- Intelligence data.
- Information management.
- Engagement coordination and status.

The most impressive aspect of JTIDS is the ability of all components of every service to possess the same digital display and voice communications system.

2. Implementation

TADIL J will be employed within the three major C2 Facilities in the proposed Marine Corps "To Be" TBMD architecture; the TACC, the TAOC, and the ADCP. The ADCP will facilitate communications between the BCP and the TAOC. The ADCP will have five separate communications links. The most important of these will be the TADIL

J link that permits direct communication between the ADCP, friendly aircraft, and other friendly forces. The TAOC will also add the TADIL J link to its components to facilitate communications between itself , the TACC, friendly aircraft, and friendly forces. The final change will occur in the TACC, which will no longer have a direct connection to other forces via TADIL A. It will, instead, add TADIL J to its communication components to facilitate communication with other agencies and with the TAOC.

E. CONCLUSIONS

Each of the advancements discussed, in one way or another, improve upon the communications system currently seen in the Marine Corps "As Is" TBMD architecture. The problems associated with information flow, its timeliness, efficiency, format and effects on decision making are, in effect, also addressed. However, these initiatives do not solve all of the problems. Problems will continue to exist if the communications equipment, physical makeup, does not change. There is still a problem with equipment redundancy and with the continued inability of C2 Facilities to completely exploit equipment capabilities, even when that equipment is present in their commands. TADIL J goes a long way towards rectifying these problems, but until it, or a technology like it, is used solely for communication, the problem will continue to exist. Problems associated with multiple equipment systems are not addressed by TADIL J, but they are a factor that needs further analysis.

Looking beyond the year 2002, the USMC TBMD system will be able to detect, identify or classify, engage, and destroy, at a sufficient range (50 km x 100 km area) all aerial targets posing a threat to stationary or mobile MAGTFs. This system will be capable of conducting simultaneous engagements in semi-automated and automated engagement modes. The system will employ netted and distributed data and information architectures within sensor and fire control elements. The TBMD system will also interoperate with THAAD, PATRIOT, and Air Force and Navy TBMD systems as part of an integrated TMD FOS.

V. CONCLUSION

A. THESIS SUMMARY

This thesis examines the Marine Corps TBMD information architecture. The main objective is to provide feedback in areas of information flow, equipment adequacy, and decision support. This thesis provides an IDEF 1X model of the Marine Corps TBMD information architecture along with matrices that, when used together, present possible analysis and clarification in three areas: Intelligence Data Flow, Battle Management Information Architecture Cohesiveness, and Battle Management Information Support. This thesis also provides an "As Is" TBMD physical architecture model and a possible "To Be" physical architecture model that are supported by the analysis. Identifying the discrepancies and a possible TBMD physical architecture provides documentation to be used in further research, development, and implementation of the concept of a joint TBMD program. The architectures studied and presented in this thesis are based on the idea of a joint, interoperable TBMD information architecture and will continue to evolve.

B. AREAS OF FURTHER RESEARCH

The restrictive nature of this thesis lead to the identification of a variety of topics which require further research. Further research of the Marine Corps TBMD concepts fall into four general categories: development of a "To Be" model to facilitate new system enhancements and technological changes, further research into developing or identifying a less complicated communications network for the proposed Marine Corps "To Be" TBMD architecture, further research into intraoperability and the proposed Marine Corps TBMD architecture, and further research into the viability of combining matrix analysis with modeling to analyze existing and future models.

1. Development of a "To Be" Model

The TBMD physical architecture is very dynamic. As such, it is important to ensure that the concept of a physical architecture is kept separate from the concept of the information architecture model. As technological changes are made to equipment, and

enhancements are made to C2 Facilities, the physical make up of the architectures will change. However, the effects on the information architecture model will be less noticeable. No matter how drastic the changes to the physical architecture, the processes and procedures contained in the model will continue to be used. The purpose of constructing the model is to develop a core structure. Once that is accomplished, changes can be incorporated without effecting the integrity of the model.

If a process becomes automated or is eliminated by a change in equipment and that change has a direct effect on the model, the change can easily be reflected in the model. For example, the implementation of TADIL J, along with the establishment of an ADCP, has a direct effect on how missile shoot commands are relayed to and from the BCP. These two implementations have a dramatic effect on the physical architecture (Appendix F, Figure F.1). However, the effects of the two implementations are not as noticeable in the model. The change in the model, at the lowest level, is to add the HAWK (ADCP) link to block A.0.5.2.2.1.1, Obtain Launch/Impact Point (Appendix B, Figure B.2, Page 79). Of course, this addition must also be reflected throughout the upper levels of the model to maintain consistency and integrity of the information contained in the model.

The systems and enhancements discussed in Chapter IV are just examples of the changes that will be made to the existing architecture. An example of the topics that will directly affect the direction of TBMD, in the Marine Corps, are interoperability and intraoperability. As more and more technologies are examined and more enhancements are proposed that address these topics, the effects on the information architecture model must also be explored. To better understand the effects of the proposals and to conduct adequate analysis, proposed changes need to be reflected within a "To Be" information architecture model.

2. Development of a Communication System

As identified in the thesis, there are many problems associated with the communications equipment employed by the C2 Facilities within the TBMD architecture. The problems range from, but are not limited to, timeliness of information received, adequacy of information received, equipment redundancy, and adverse effects on the

decision making process. It is clear, from the analysis presented in Chapter III, that the need for a more streamlined communications system exists. The development of TADIL J goes a long way toward addressing some of the communications problems, but until the number of different communication equipment is curtailed or protocol standards exist which allow heterogeneous equipments to interoperate, the problem will persist. Concerns about the lack of exploitation of equipment capabilities and the need for multiple equipment types need to be addressed.

3. Intraoperability Problems

Intraoperability is not covered in this thesis, but it is a very important issue. As much as a simple, easy to use communications network is needed for the TBMD architecture, it must be made clear that the development of such a system must coincide with the communications developments of other entities within the Marine Corps. A prime example of this type of development is the TADIL J communications link. TADIL J was a development project aimed directly at the issue of intraoperability and interoperability.

The goal of the Marine Corps, as stated in Chapter III, is to seamlessly integrate the TBMD Architecture into the MAGTF C4I Architecture and provide effective and efficient missile defense. In order to accomplish this goal, it is necessary for the MAGTF forces involved with TBMD to communicate with other units within the Marine Corps (Appendix A, Figure A.1 and Appendix F, Figure F.1). This intraservice communication capability is a prime example of intraoperability. Intraoperability is an area of study that is getting more than its share of attention as of late. This is especially true with TBMD since all commands within the Marine Corps are involved in the development of a cohesive TBMD Architecture [Ref. 9]. The effects of intraoperability on the physical TBMD architecture must be examined and documented with the development of any and all new enhancements or technologies.

4. Matrix Analysis

Matrix analysis is a tool for examining models. It gives the reader an ability to understand difficult or complex processes. It also affords them an opportunity to adequately examine subjects not in their realm of expertise. However, the effectiveness of matrix

analysis is questionable because of the procedures involved with accomplishing the analysis. In order for a proper analysis to be accomplished, certain elements have to be present. First, a thorough model of the procedures and processes needs to be constructed. Second, matrices that accurately depict the information contained in the model, and that address relevant topics, needs to be constructed. Finally, in order to accomplish steps one and two, a subject-matter expert must be either available for consultation or be directly involved with the study. The development of the model is an important step and should not be trivialized. However, many models already exist. The problem begins with construction of matrices for these models. As discussed in Chapter II, the areas of concern for this thesis were already known before construction of the matrices was attempted. Without the subject-matter expert's input, construction of the matrices would have been equivalent to finding a needle in a haystack. What is at issue here is whether or not the matrices can be constructed without the aid of a subject-matter expert. Procedures for the development of matrices without aid from subject-matter experts must be developed.

C. CONCLUSION

This thesis establishes strong evidence that the existing Marine Corps "As Is" TBMD architecture is inadequate in its current state. Through the use of a model, matrices, and matrix analysis, a comprehensive study was accomplished that identified the communications equipment infrastructure as the key to the inadequacies. The existence of multiple equipment systems within the communications environment directly affects the stability of the Theater Ballistic Missile Defense architecture.

The Marine Corps choice of combining the TACC/TAOC/SAAWC, AN/TPS-59, and HAWK system, inevitably lead to the problem of equipment redundancy. These C2 Facilities are outfitted, in the Table of Organization (T/O), with numerous overlapping communications capabilities. Those overlapping capabilities are not, however, incorporated throughout every C2 Facility since the equipment is not universally dispersed. This redundancy leads to information flow problems. Information format and information timeliness are effected considerably by equipment redundancy. There is no analytical

evidence that suggests that multiple equipment systems are necessary to carry out mission object. In fact, the analysis in Chapter III identified problems which make it clear that there is a need to consolidate the communications infrastructure.

The initial TBMD architecture was developed to take advantage of the communications structures already present in the MAGTF's environment. However, those capabilities are overshadowed by the architect's lack of exploitation of the equipment capabilities. Information flow, in particular, is adversely impacted in the existing infrastructure. The lack of timely information is unacceptable given the precarious nature of the mission objectives. Information flow, timeliness in particular, is affected by information adequacy, information format, and information processing (fusing and correlating data) or a combination of the three. The absence of any or all of these traits can have a detrimental effect on TBMD. The communications structure within the TBMD environment, as depicted in Chapter III, is not conducive to efficiency in any one of these areas. The result of the communications dilemma is the inability of the architecture to support good decision making. The resulting effect is poor performance.

TBMD, on the MAGTF level, has not been battled tested. The need for TBMD did not arise until the Persian Gulf War had already started. The lessons learned in that time frame made it necessary for the Marine Corps to quickly assemble an infrastructure that dealt with the problem. However, if the Marine Corps is going to integrate the TBMD Architecture into the MAGTF C4I Architecture and provide effective and efficient missile defense, it has to start building an architecture to deal with these future needs. Those needs are centered around communications and intraoperability and interoperability.

APPENDIX A. USMC "AS IS" ARCHITECTURE

A. USMC "As Is" AAW/HAWK Configuration

The existing configuration (Figure A.1) consists of three key elements.

1. Tactical Air Command Center (TACC)

The TACC is the senior agency within the Marine Air Command and Control System (MACCS) and as such, is responsible for the overall supervision, coordination, and control of tactical air operations in the Marine Corps area of responsibility [Ref. 12]. The TACC provides facilities from which the Air Combat Element (ACE) Commander and his battle staff plan, supervise, coordinate, and execute all current and future Marine Air Ground Task Force (MAGTF) air operations. The TACC also provides integration, coordination and direction of joint and combined air operations. The TACC is dependent upon three separate communications links[3].

a. TADIL A

The TADIL A (Link 11) is a HF/UHF, half duplex link that is used to exchange air, surface, and subsurface tracks and points in real and near-real time. It provides two-way communication between the TACC and other military components.

b. TADIL B

The TADIL B (Link 11B) is a multi-channel radio, full duplex link that is used to exchange air, surface, and subsurface tracks and points in real and near-real time. It provides two-way communication between the TACC and the Tactical Air Operations Center (TAOC) and the TACC and other military components.

c. NATO Link 1

The NATO Air Defense Ground Environment (NADGE) Link 1 is a multi-channel radio, duplex link used to exchange air tracks and points in real time. It provides two-way communication between the TACC and NATO forces.

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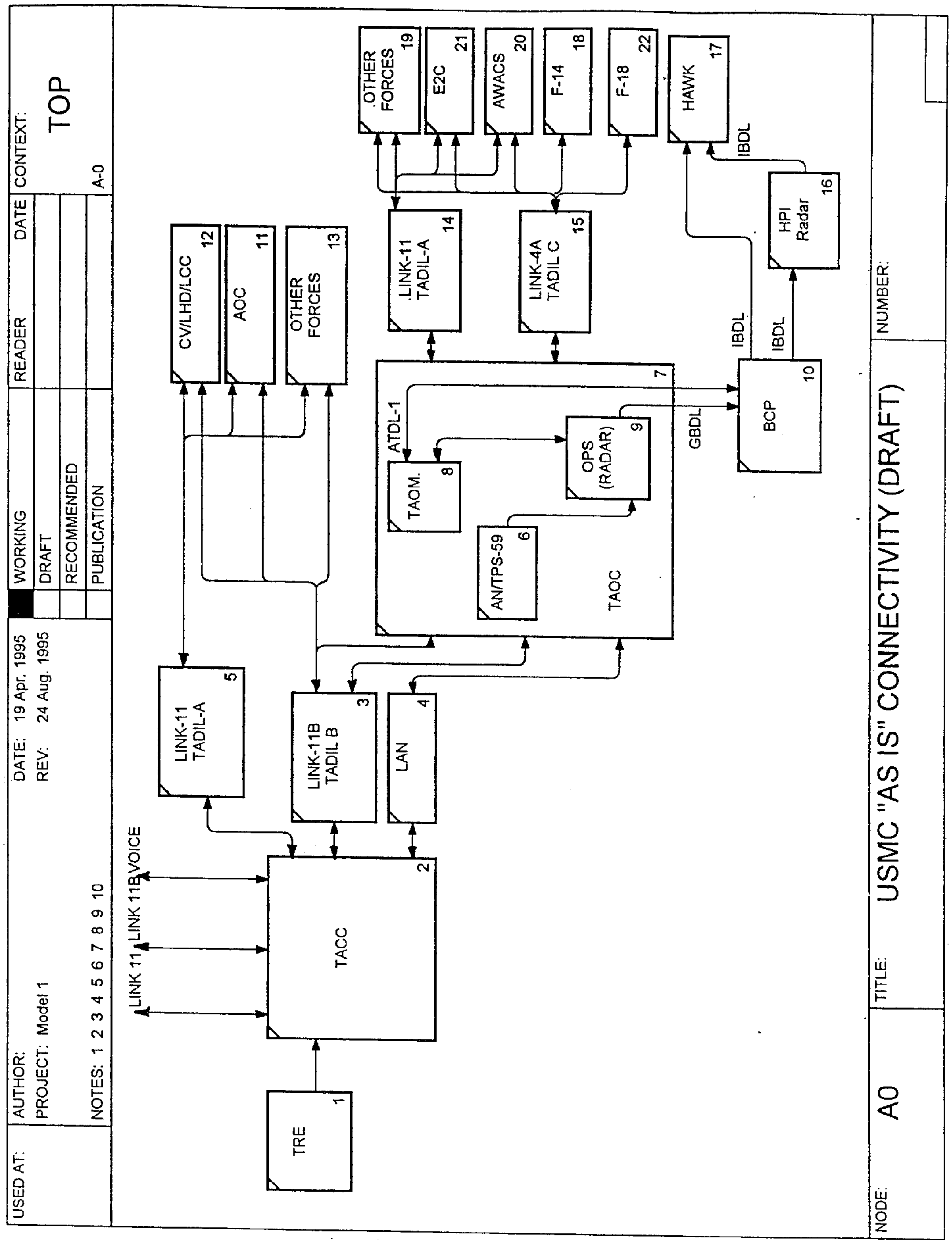
[3]The TACC also employs a LAN to facilitate communications between the TACC and the TAOC.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TACC 2
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LINK 11B
VOICE
LINK-11B TADIL B 3
LAN 4
LINK-11 TADIL-A 5
AN/TPS-59 6
TAOC 7
TAOM. 8
OPS (RADAR) 9
ATDL-1
GBDL
BCP 10
AOC 11
CV/LHD/LCC 12
OTHER FORCES 13
LINK-11 TADIL-A 14
LINK-4A TADIL C 15
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A0
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USMC "AS IS" CONNECTIVITY (DRAFT)
NUMBER:

Figure A.1

2. Tactical Air Operations Center (TAOC)

The TAOC acts as the senior air defense agency within the MAGTFs assigned sector of responsibility. The TAOC preforms the function of air surveillance and early warning, aircraft control, and controls all surface-to-air missile fires within its assigned sector [Ref. 12]. The TAOC is composed of multiple Tactical Air Operations Modules (TAOM), a AN/TPS-59 radar, and an operations center. The TAOC performs real-time direction and control of all AAW operations, including manned interceptions and surface-to-air weapons. By collecting and displaying information from its own sensors, other Marine Corps sources, and external sources, the TAOC controls assigned airspace and directs and controls the fire of assigned air defense assets. The TAOC employs TADIL A and three other major communications links[4].

a. TADIL C

The TADIL C (Link 4A) is a Marine Corps System Operator (manual), half duplex link that is used for aircraft control. It provides two-way communication between the TAOC and friendly aircraft.

b. ATDL-1

The Army Tactical Data Link (ATDL-1) is a multi-channel radio, full duplex link that is used to exchange air tracks and points in real and near-real time. It provides two-way communication between the TAOC and friendly aircraft.

c. GBDL

Ground Based Data Link is a LAN system that is used to exchange target and fire control information. It provides two-way communication between the TAOC and the Battery Command Post (BCP).

3. Battery Command Post (BCP)

The BCP functions as the control facility for the HAWK surface-to-air missile system [Ref. 1]. The BCP provides the required communications and processing functions to enable

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[4]The TAOC also employs an internal LAN/WAN to facilitate communications between the AN/TPS-59 radar and the Operations Center.

HAWK firing sections to engage air breathing targets (ABT). The Continuous Wave Acquisition Radar (CWAR) and Pulse Acquisition Radar (PAR) detect ABTs at medium altitudes and ranges, but have no role against the Theater Ballistic Missile (TBM) threat. The High Power Illuminator (HPI) designates the target for intercept by the missile. In operation, the PAR, CWAR, or AN/TPS-59 radar processes and forwards a track to the BCP, the command level command, control, communications, and intelligence (C3I), and the fire control center. When the target approaches the engagement range of the HAWK interceptor, the BCP assigns the target to a HPI for acquisition and tracking. The BCP calculates the fire control solution, designates an interceptor, and issues fire control and initialization commands to the launcher and the missile. The BCP employs an Intra-Battery Data Link (IBDL) to facilitate communications between the BCP, The HPI and the HAWK missile platform.

APPENDIX B. USMC "AS IS" IDEF MODEL

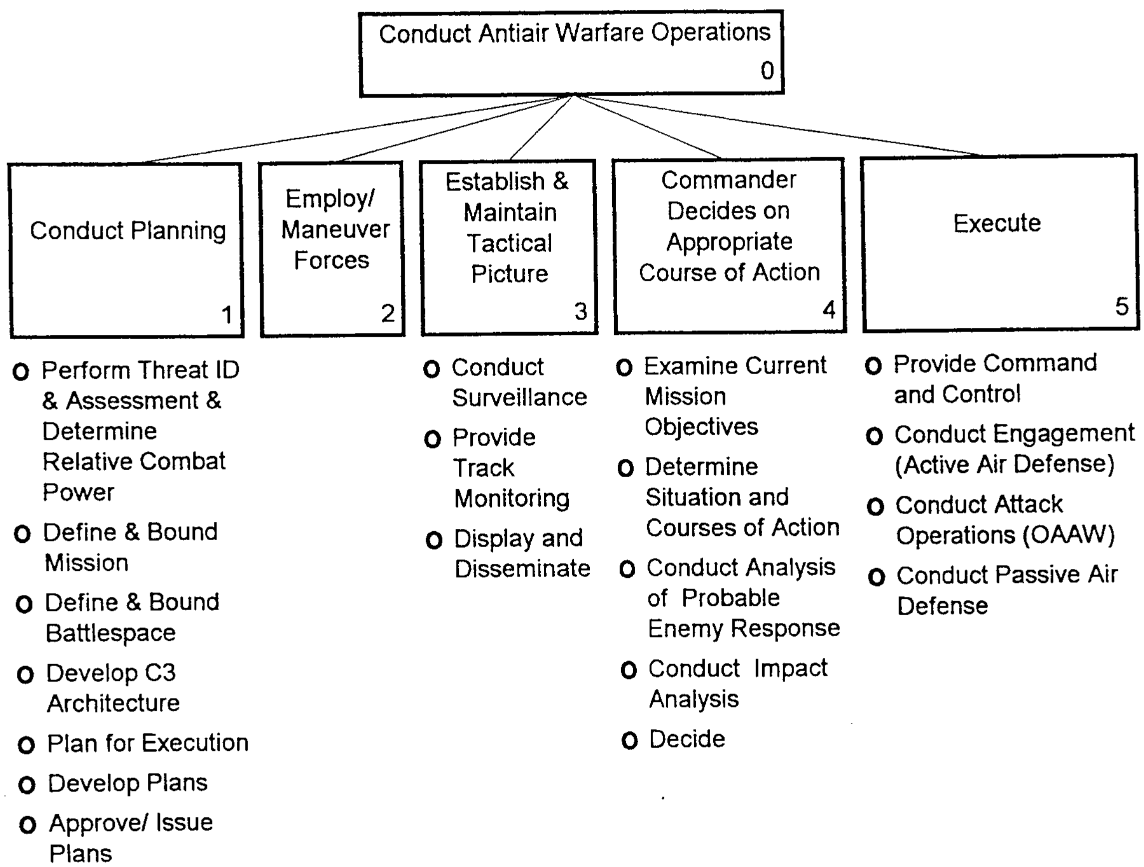
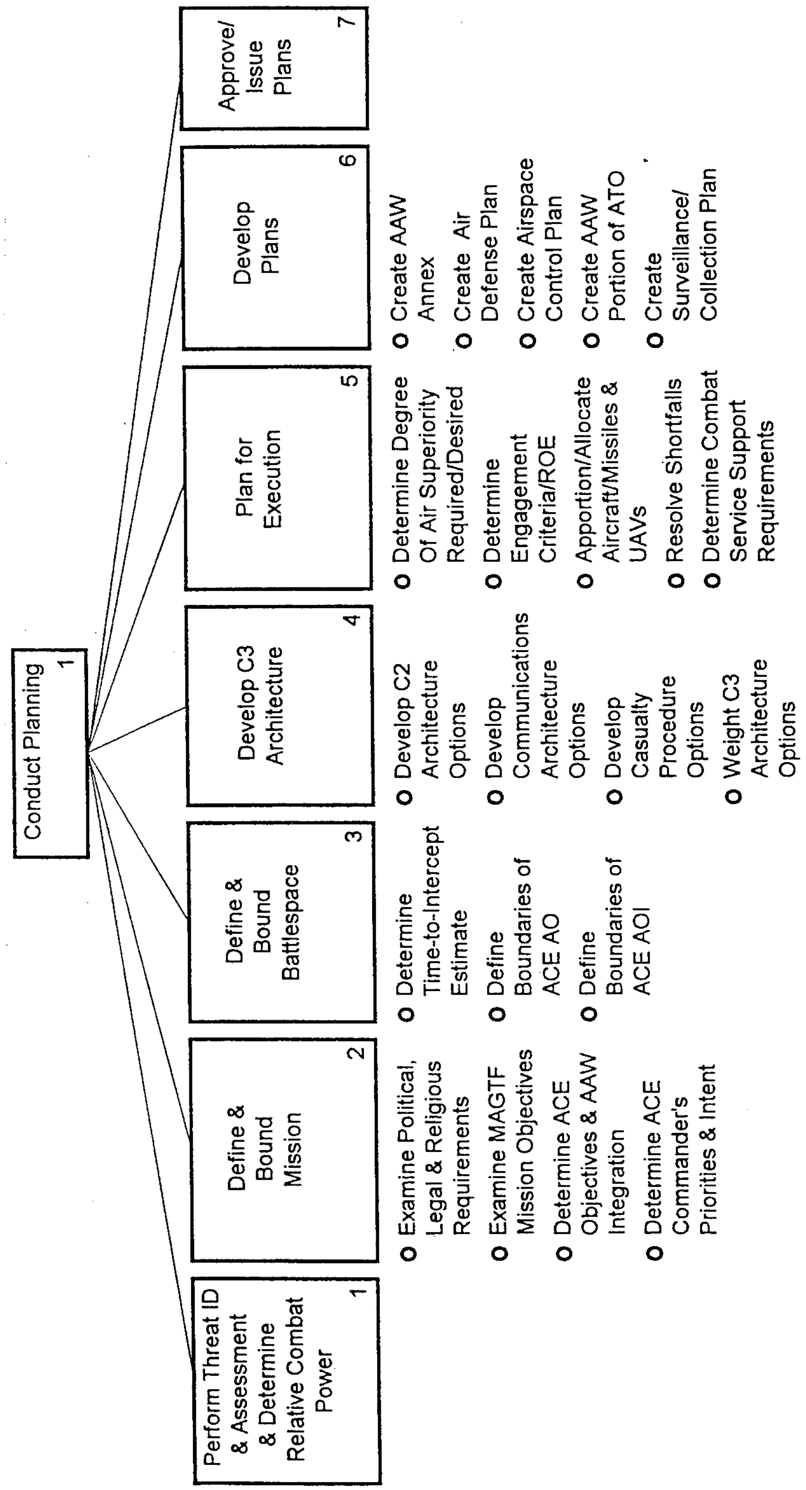


Figure B.1



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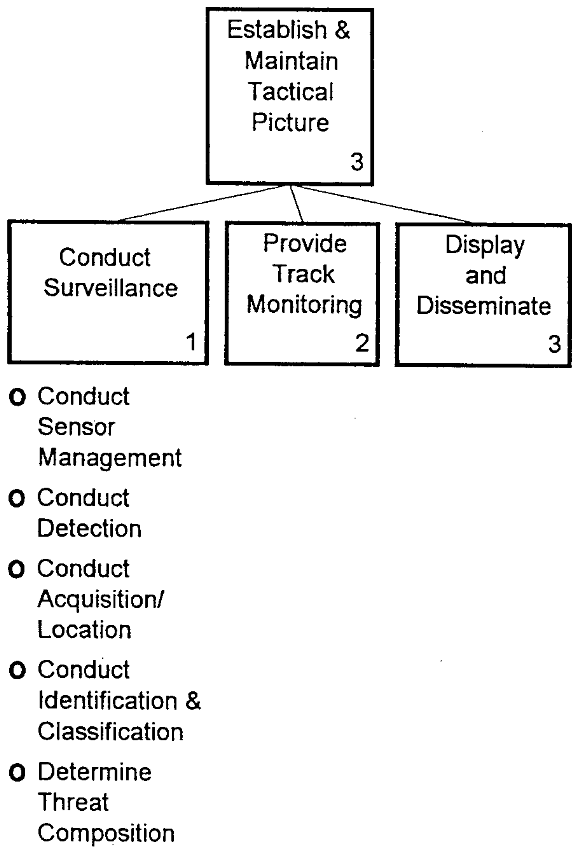

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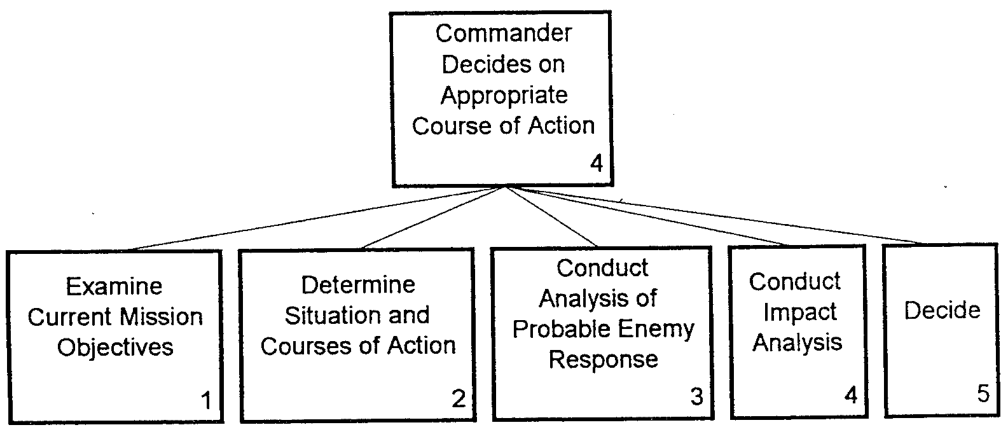

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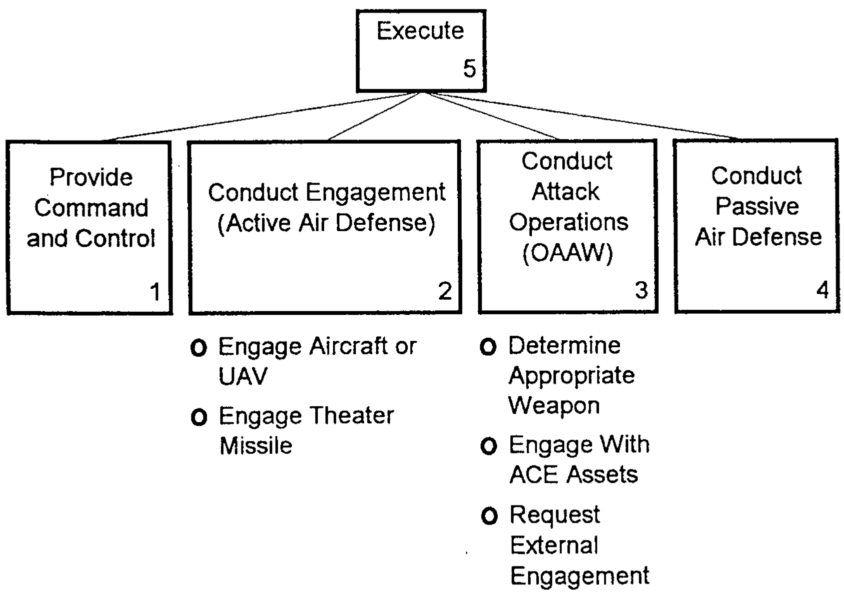

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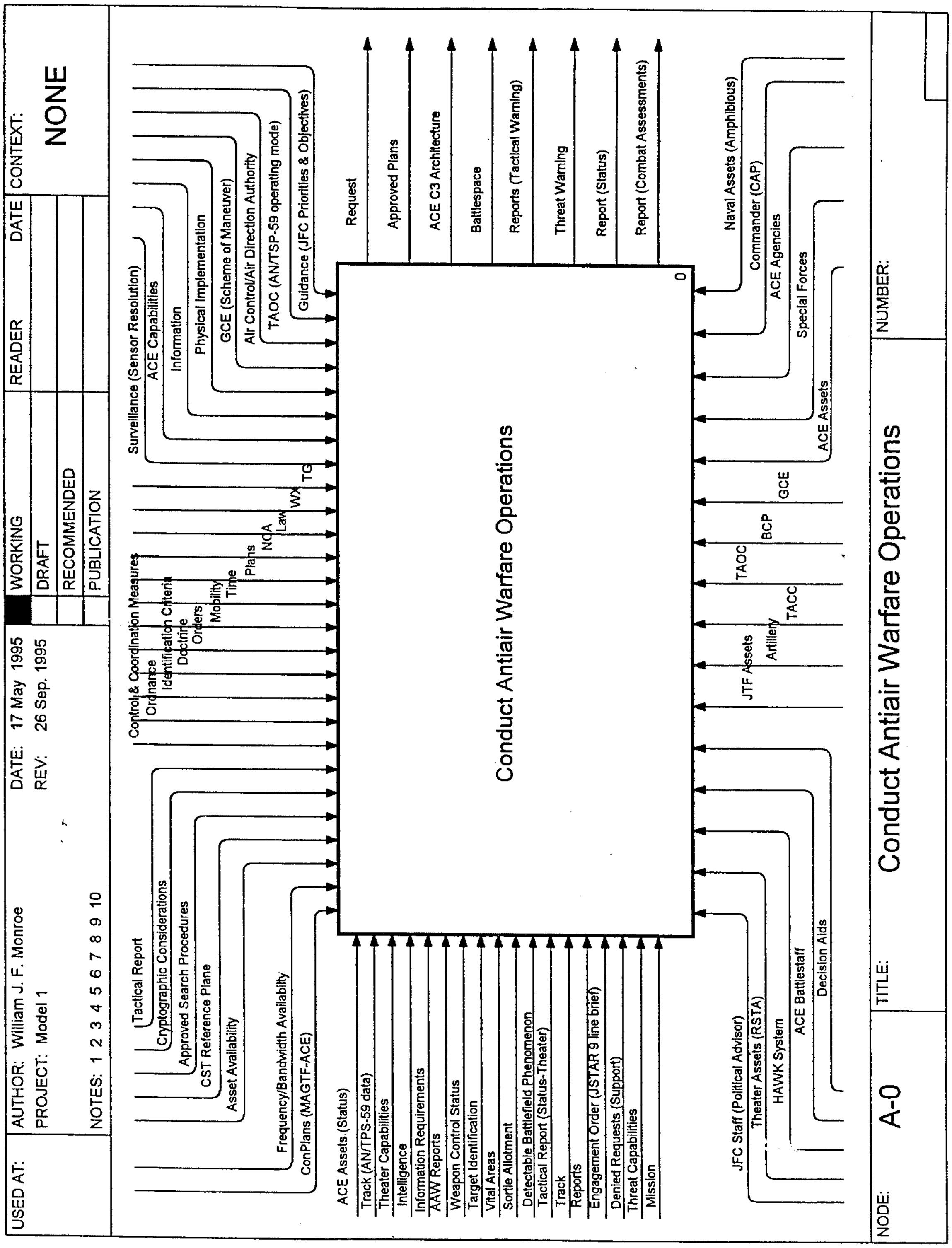
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Doctrine
Orders
Mobility
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Plans
NCA
Law
WX
TG
Surveillance (Sensor Resolution)
ACE Capabilities
Information
Physical Implementation
GCE (Scheme of Maneuver)
Air Control/Air Direction Authority
TAOC (AN/TSP-59 operating mode)
Guidance (JFC Priorities & Objectives)
Request
Approved Plans
ACE C3 Architecture
Battlespace
Reports (Tactical Warning)
Threat Warning
Report (Status)
Report (Combat Assessments)
Conduct Antiair Warfare Operations
0
ACE Assets (Status)
Track (AN/TPS-59 data)
Theater Capabilities
Intelligence
Information Requirements
AAW Reports
Weapon Control Status
Target Identification
Vital Areas
Sortie Allotment
Detectable Battlefield Phenomenon
Tactical Report (Status-Theater)
Track
Reports
Engagement Order (JSTAR 9 line brief)
Denied Requests (Support)
Threat Capabilities
Mission
JFC Staff (Political Advisor)
Theater Assets (RSTA)
HAWK System
ACE Battlestaff
Decision Aids
JTF Assets
Artillery
TACC
TAOC
BCP
GCE
ACE Assets
Special Forces
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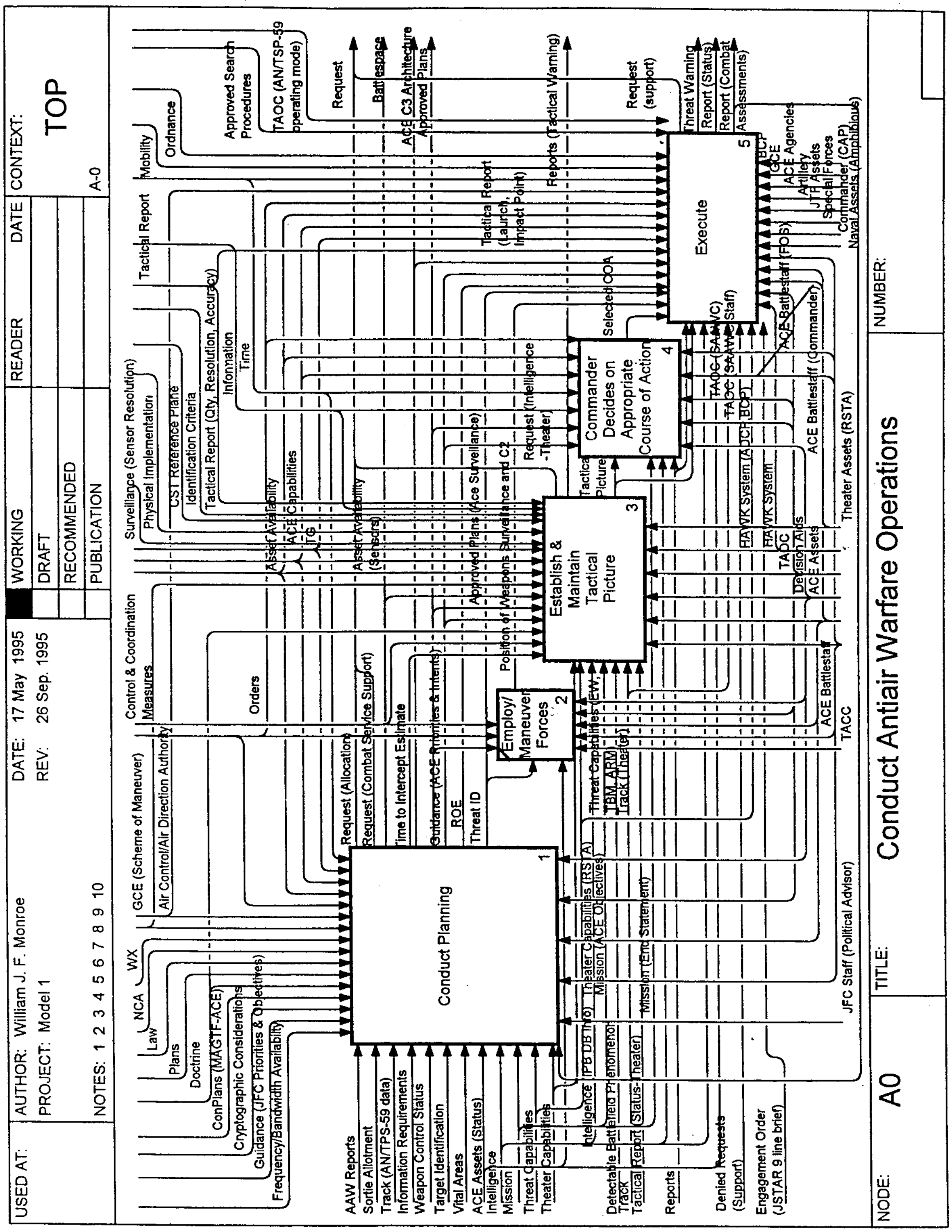
Figure B.2



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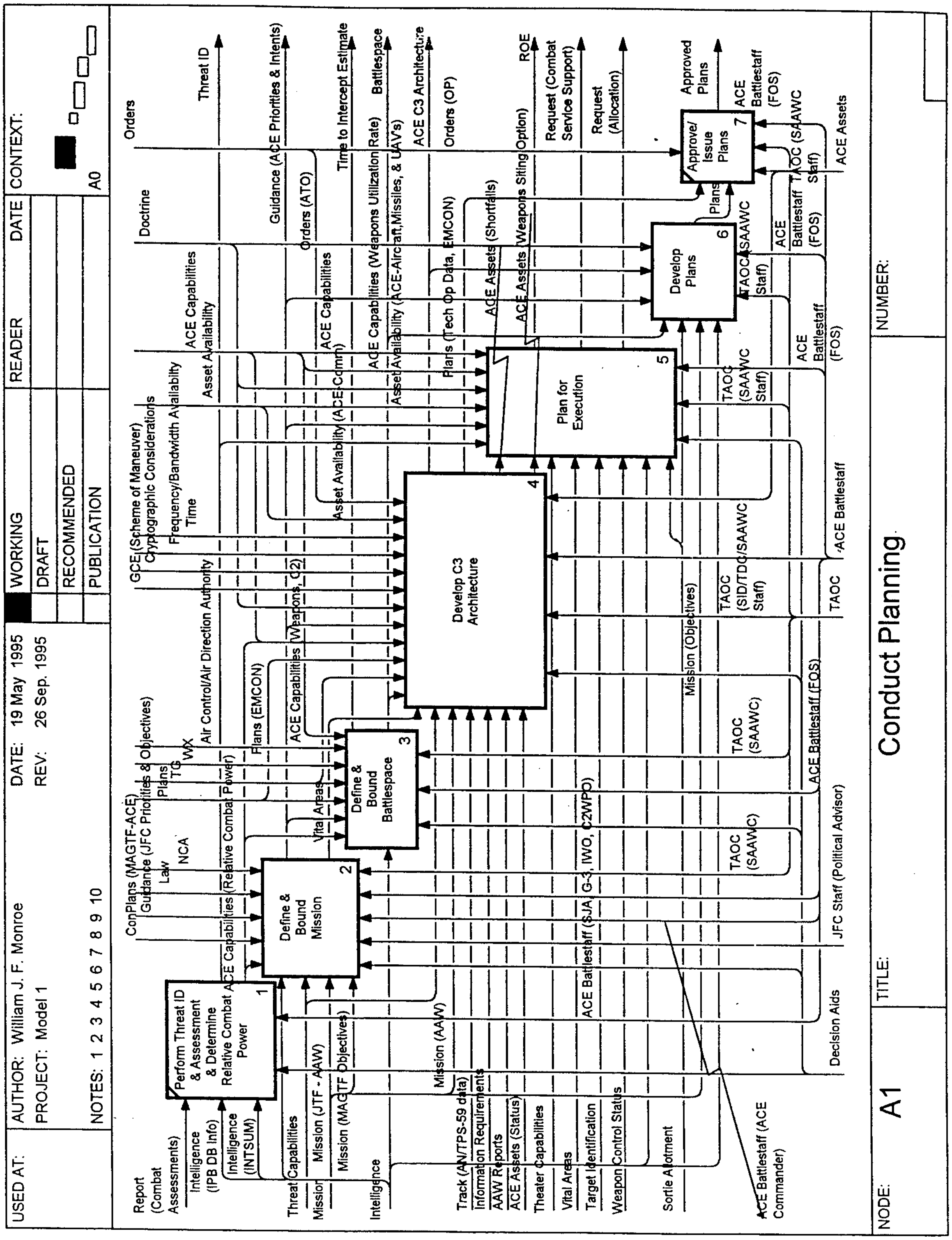

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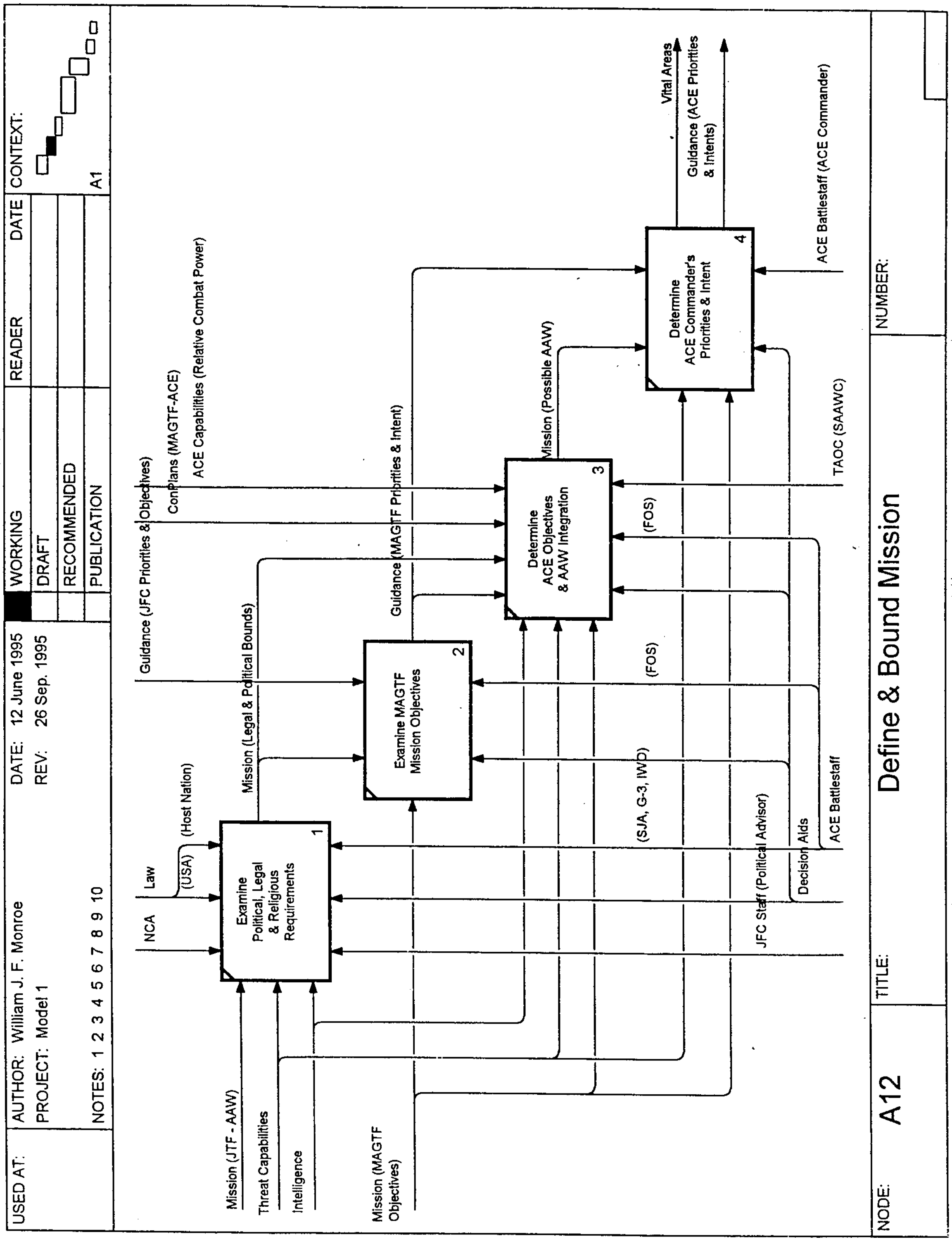

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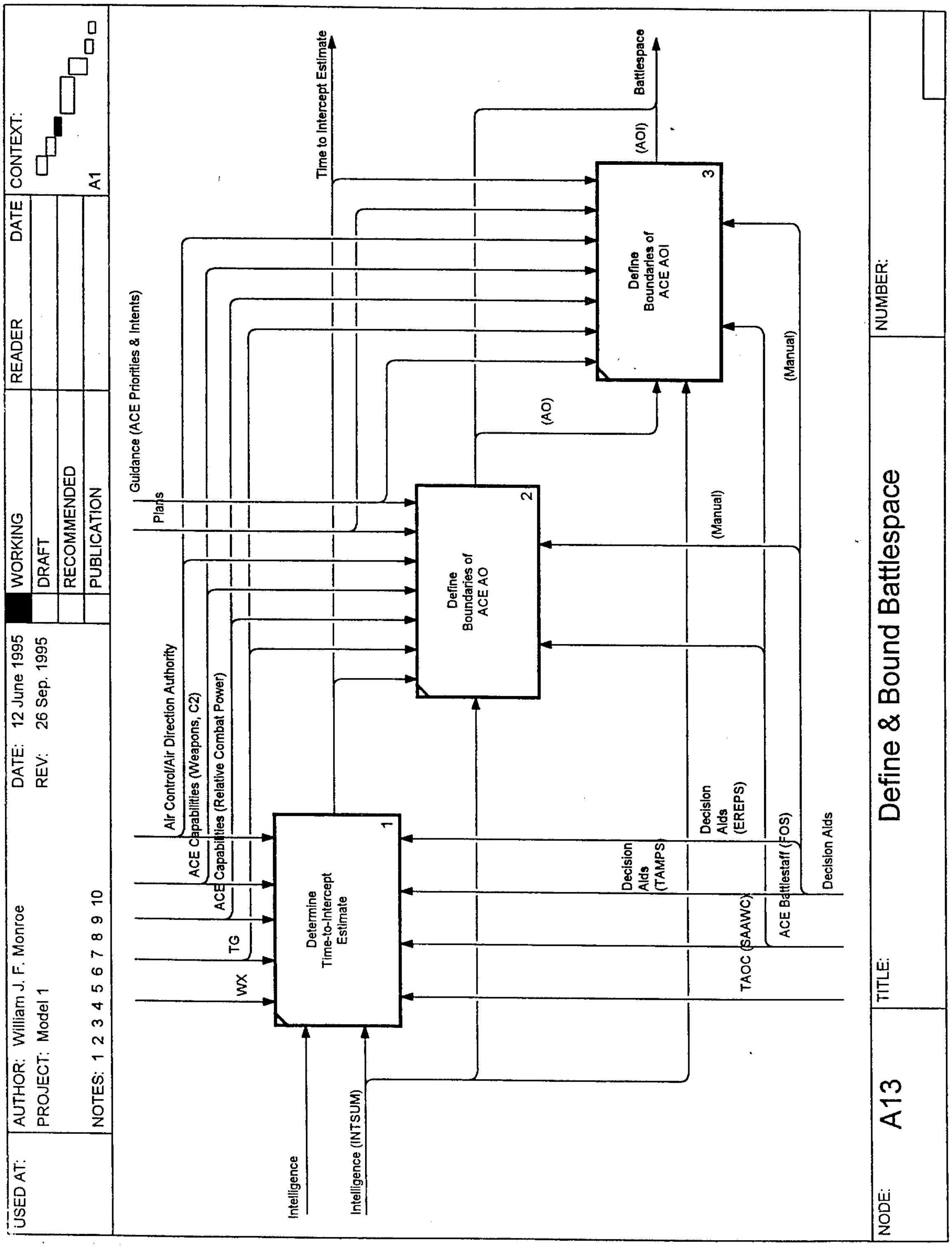

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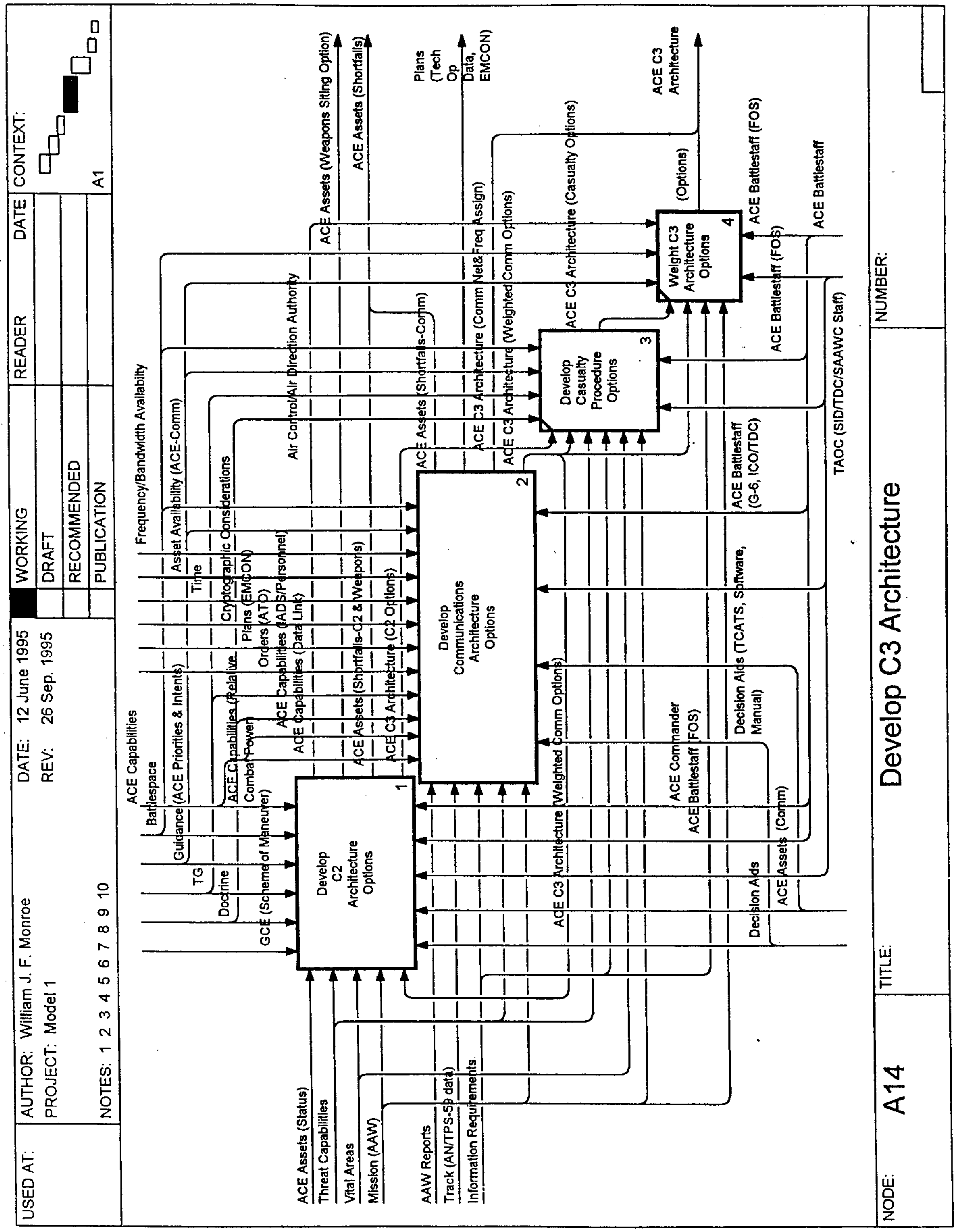

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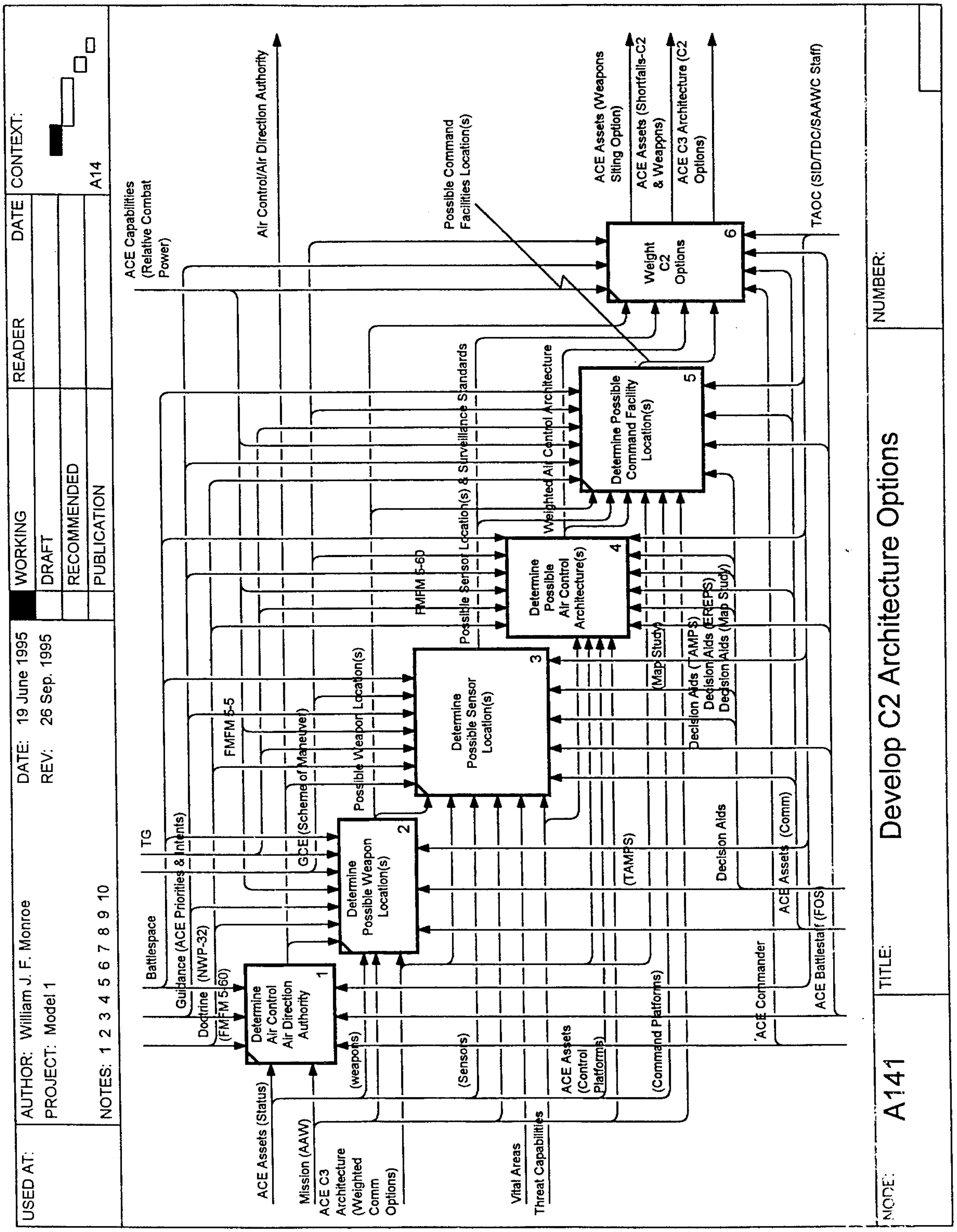

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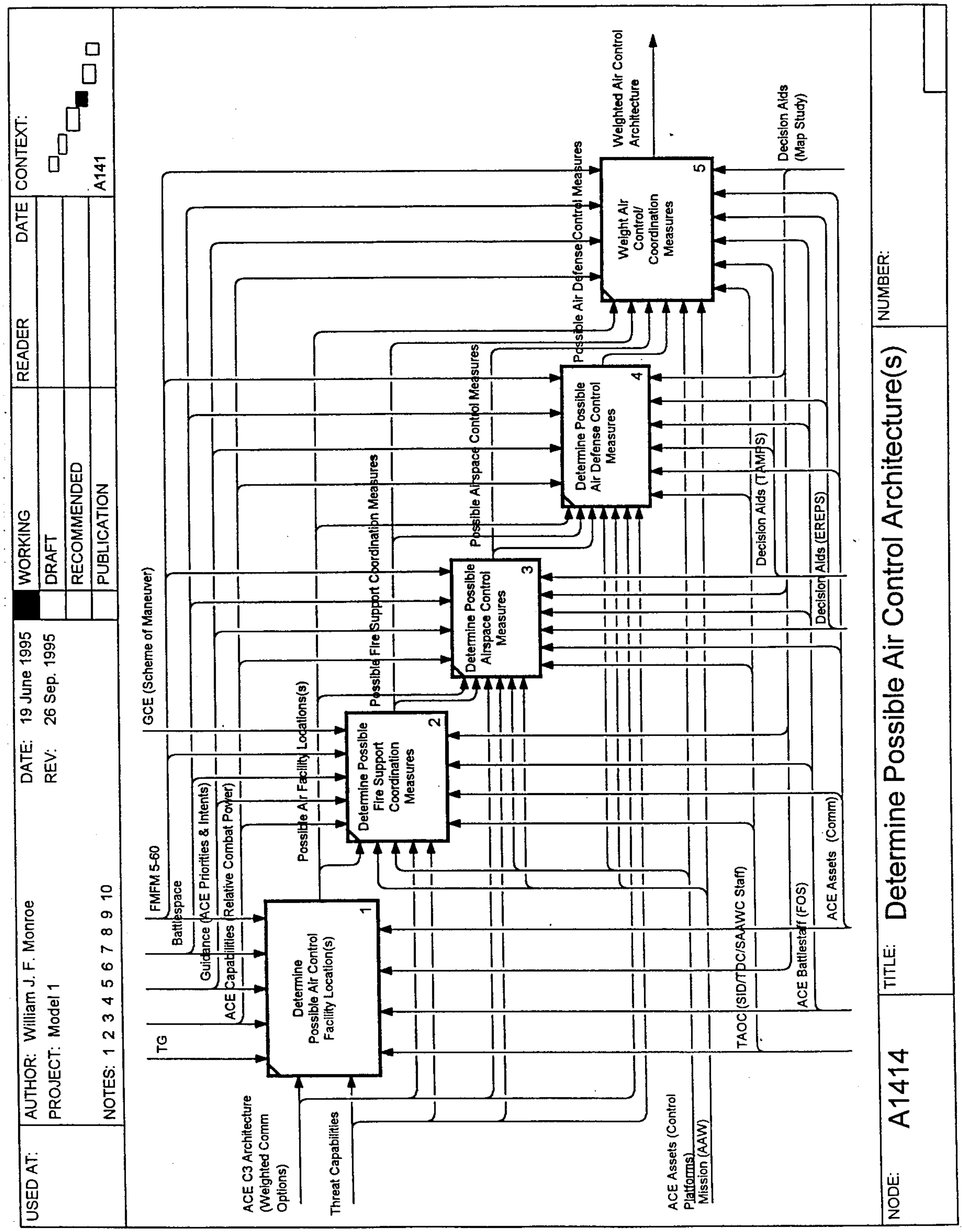

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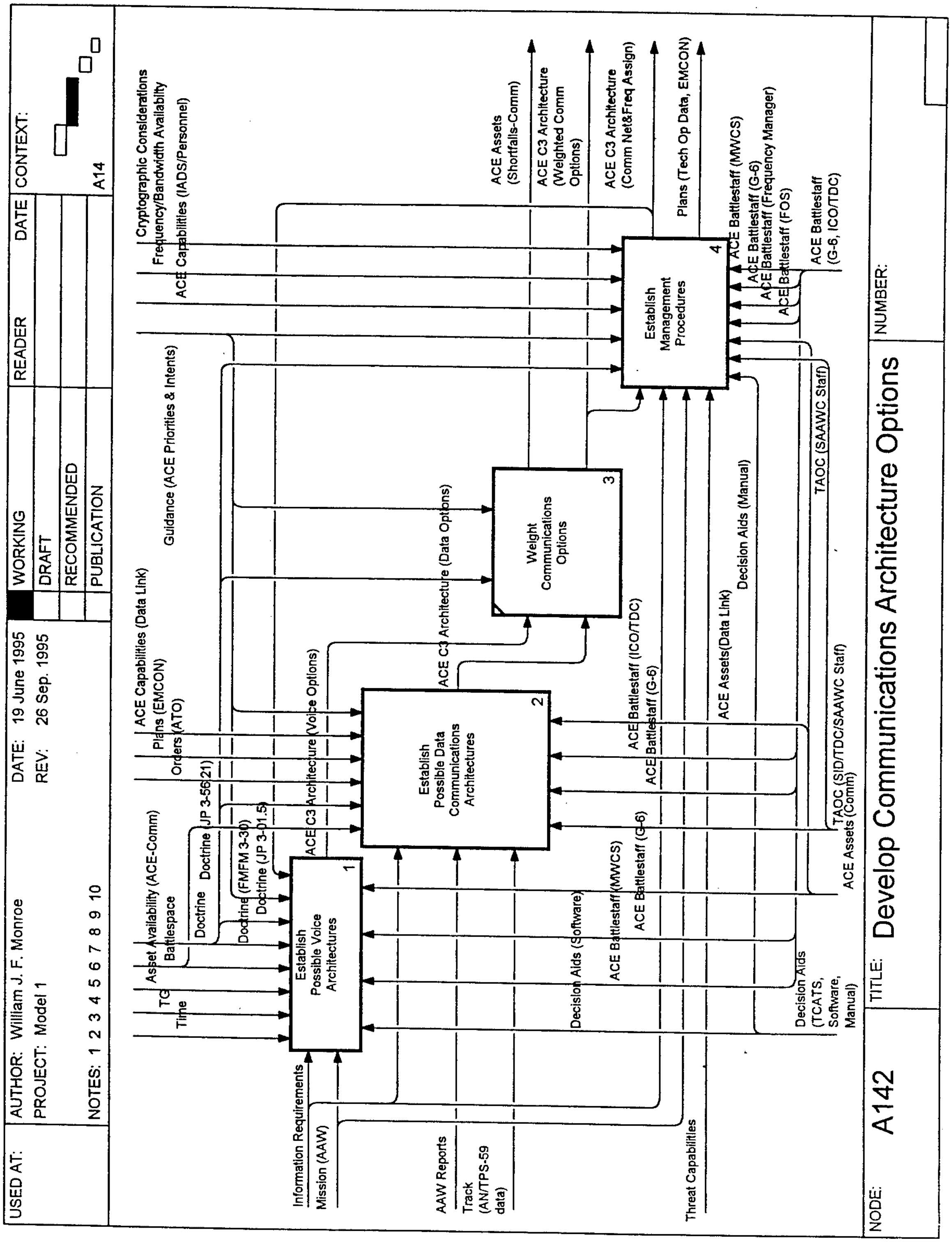

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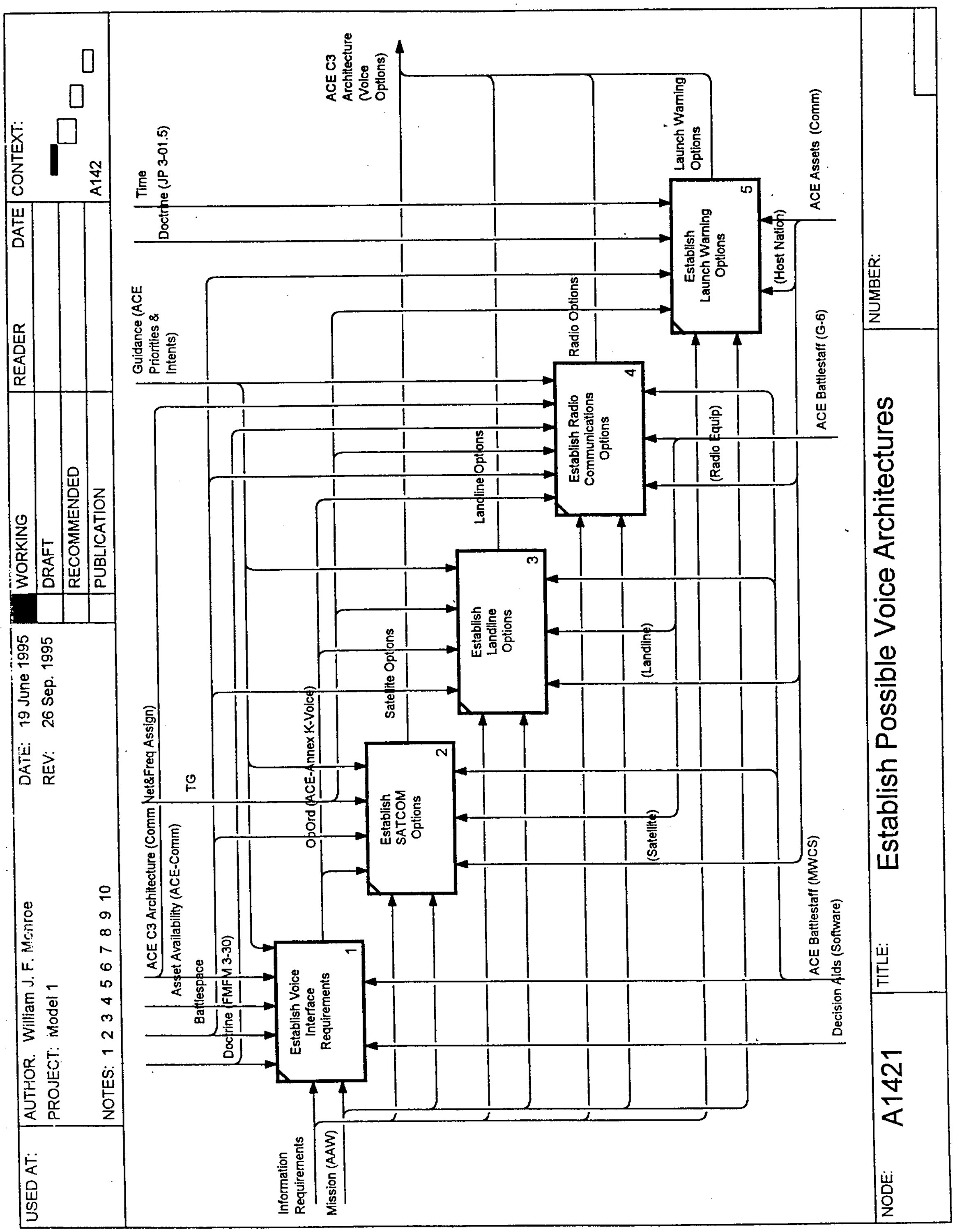

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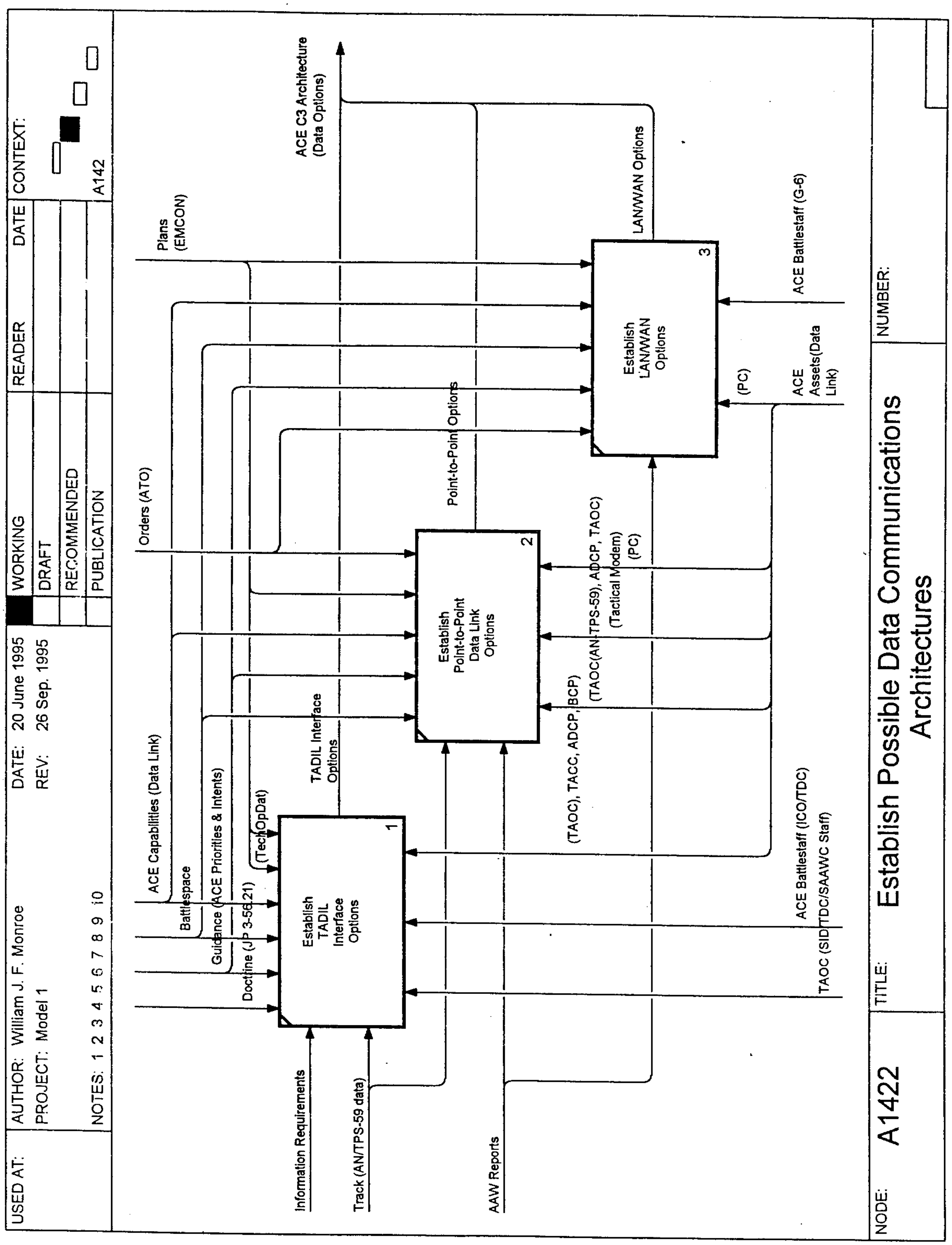

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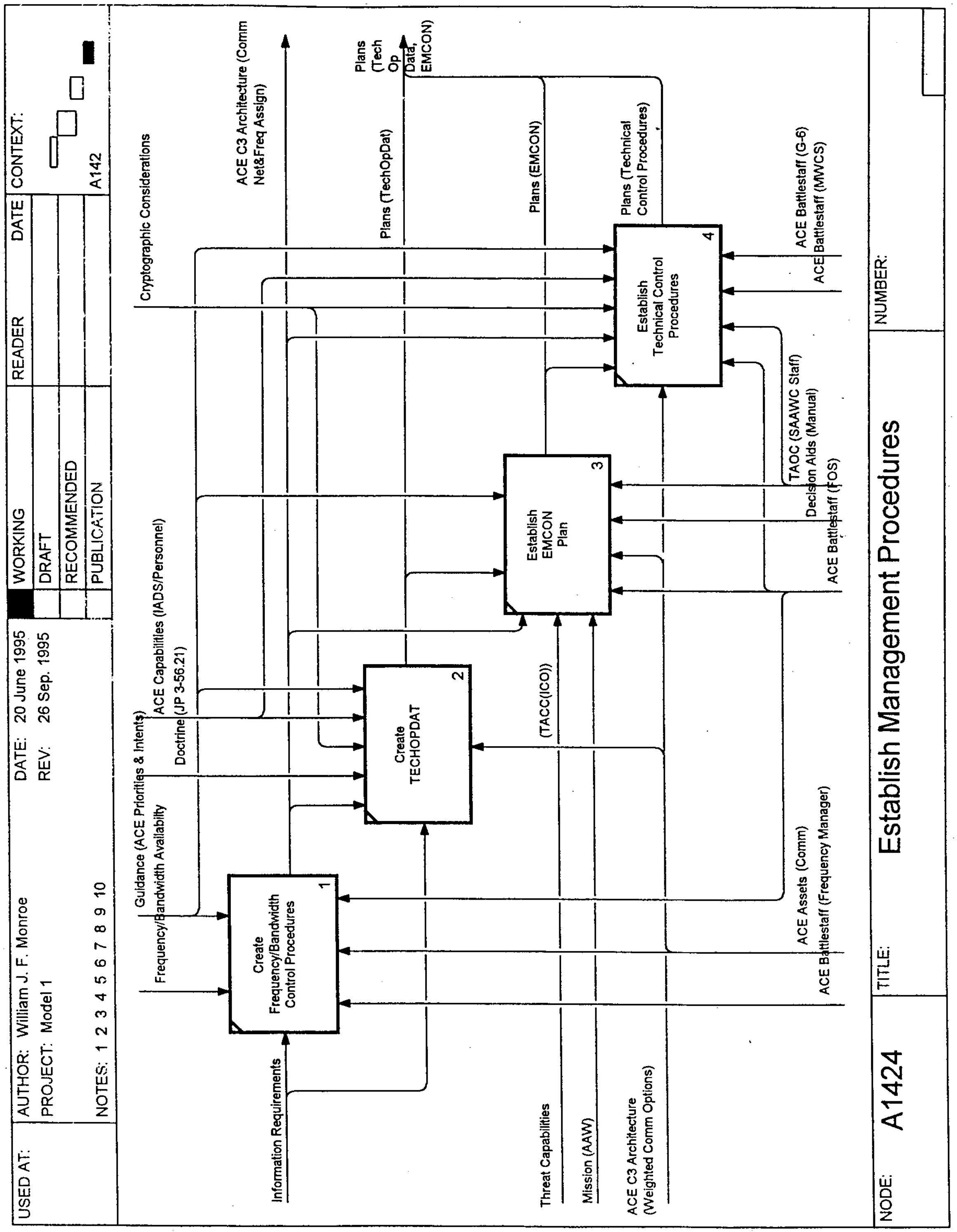

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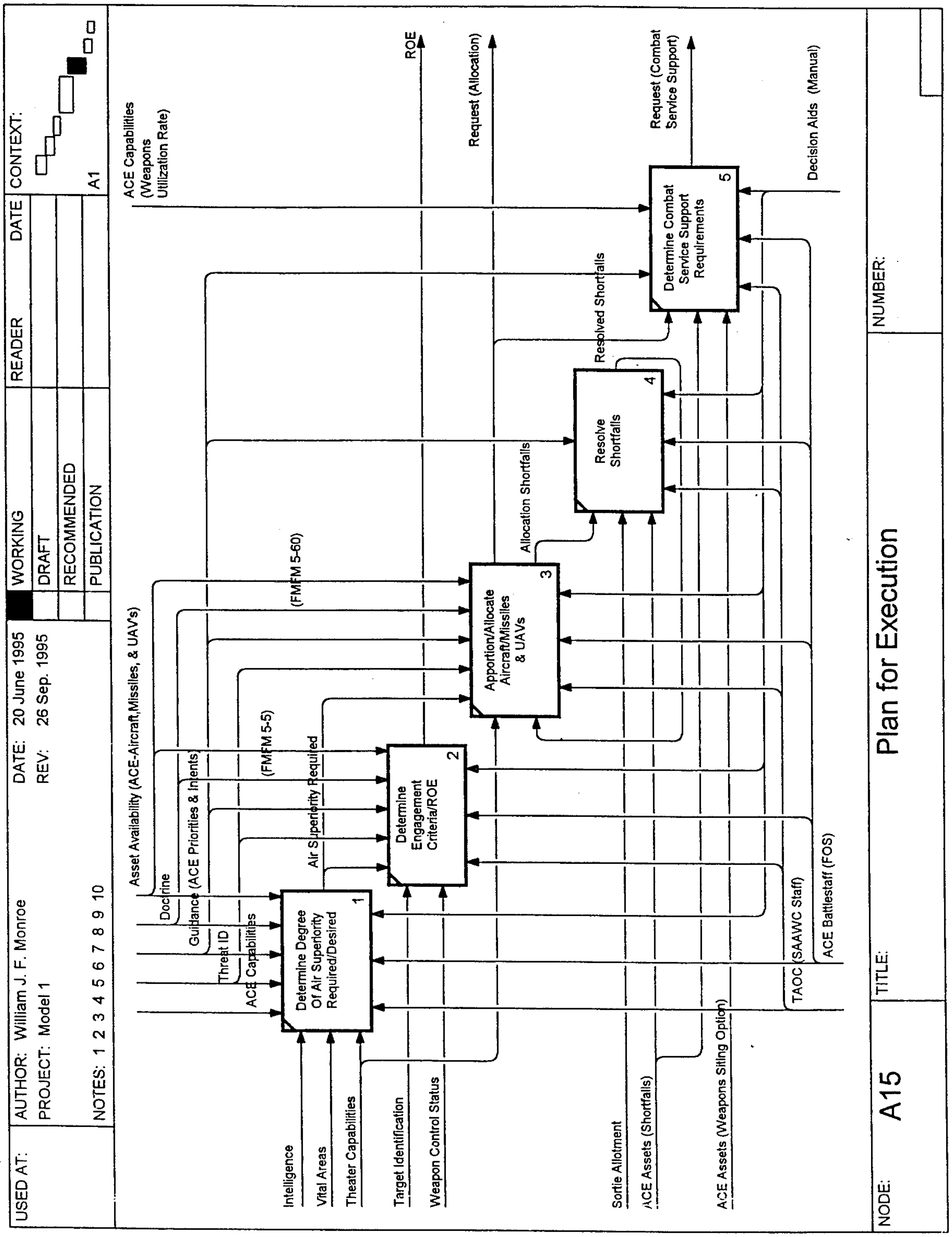

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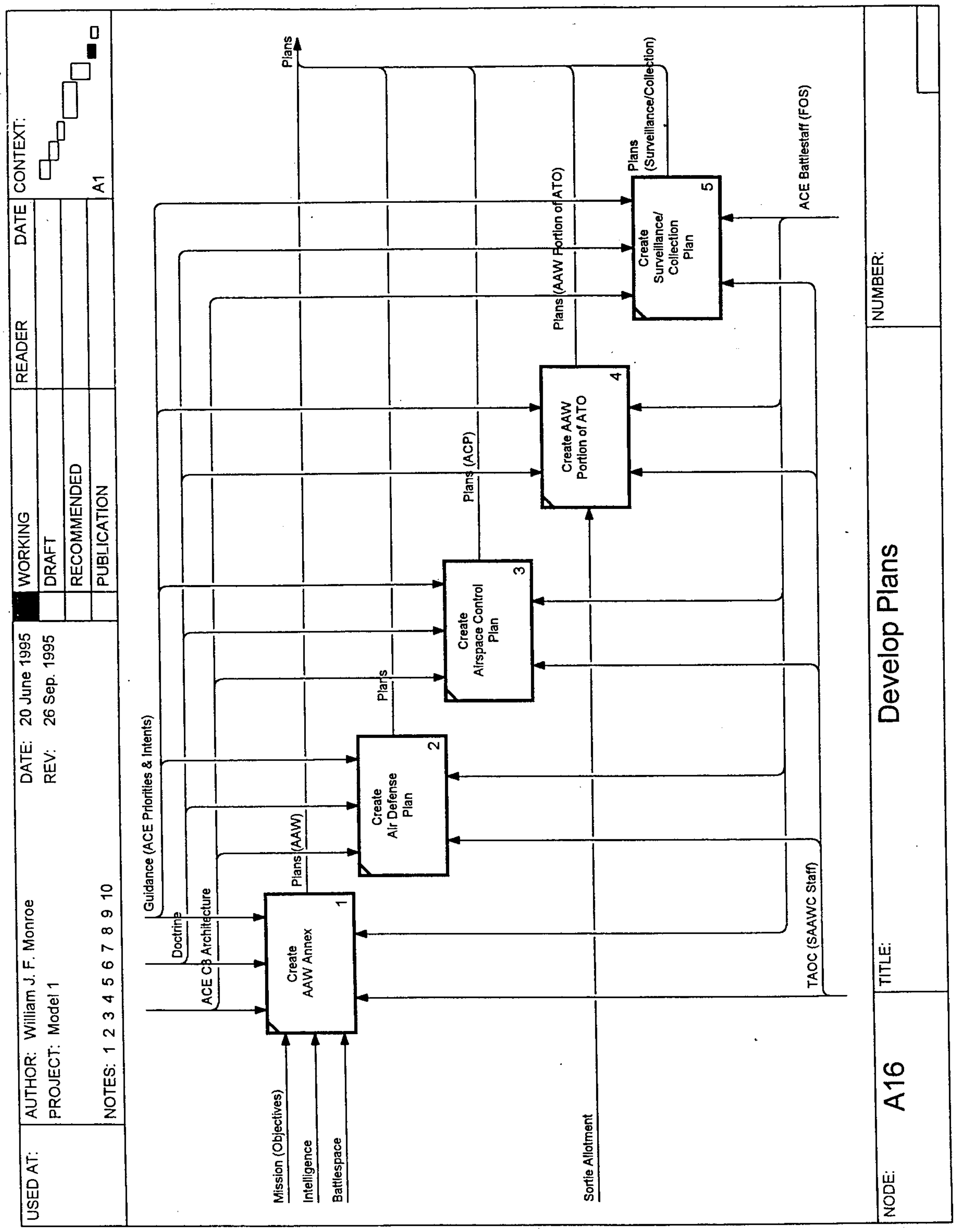

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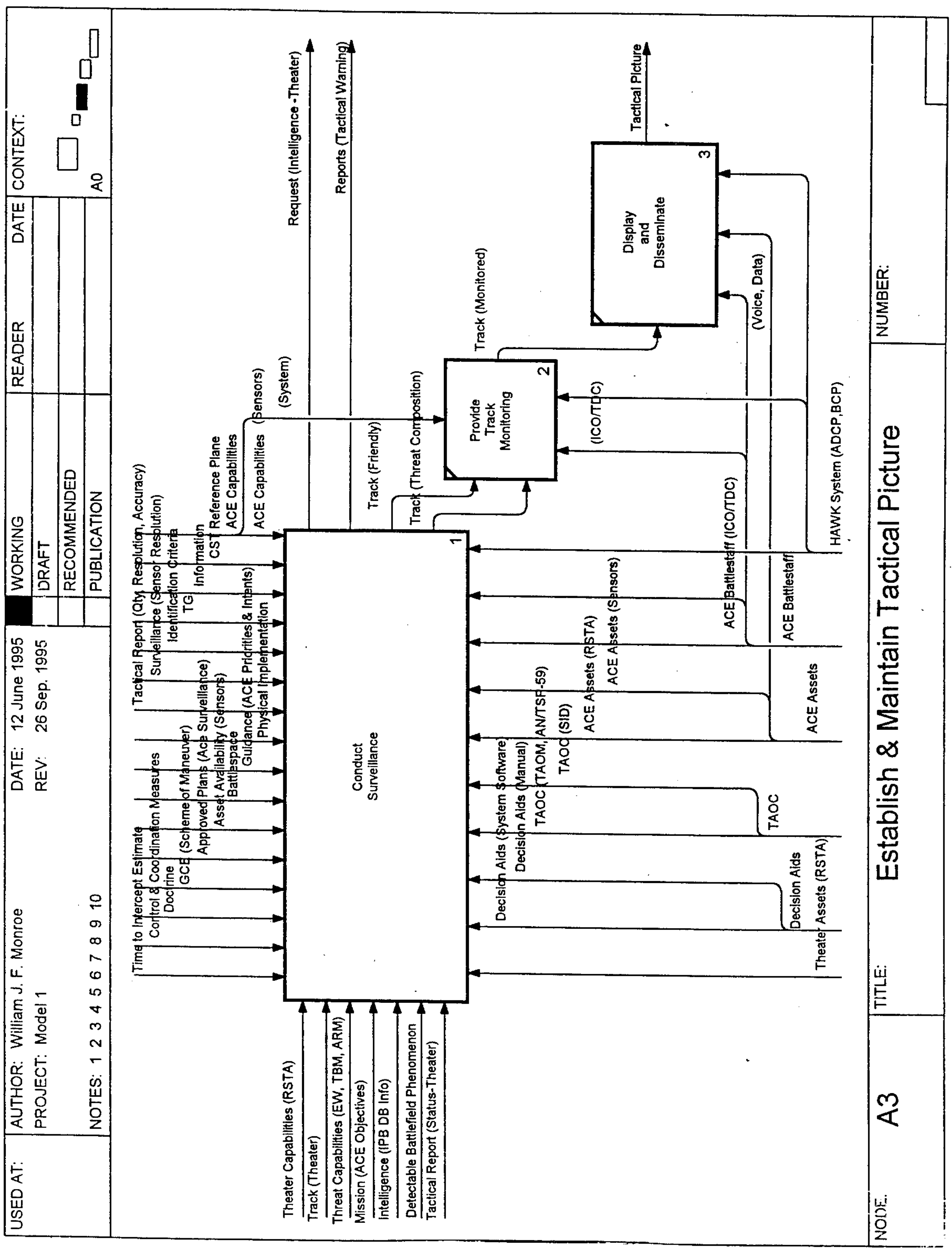

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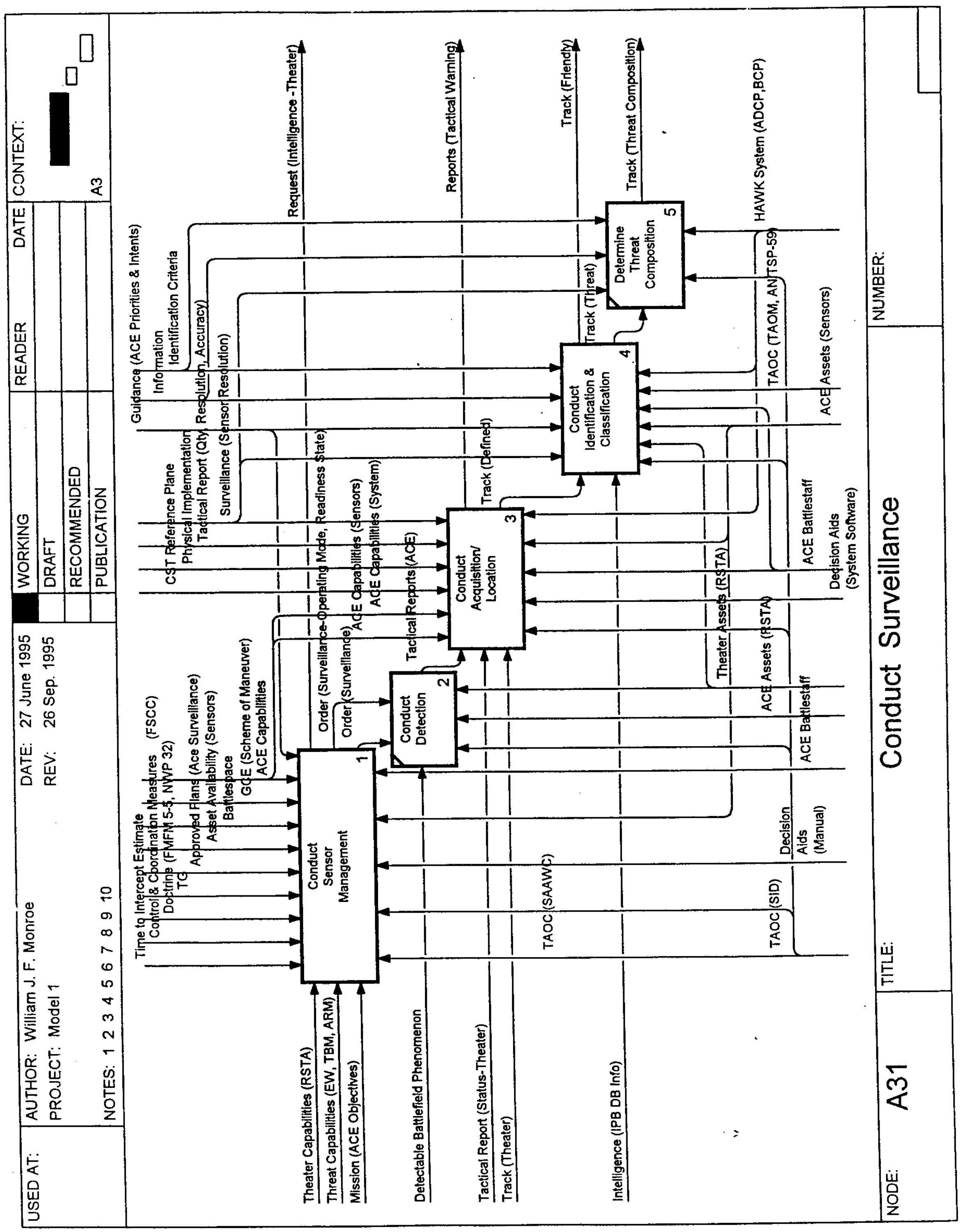

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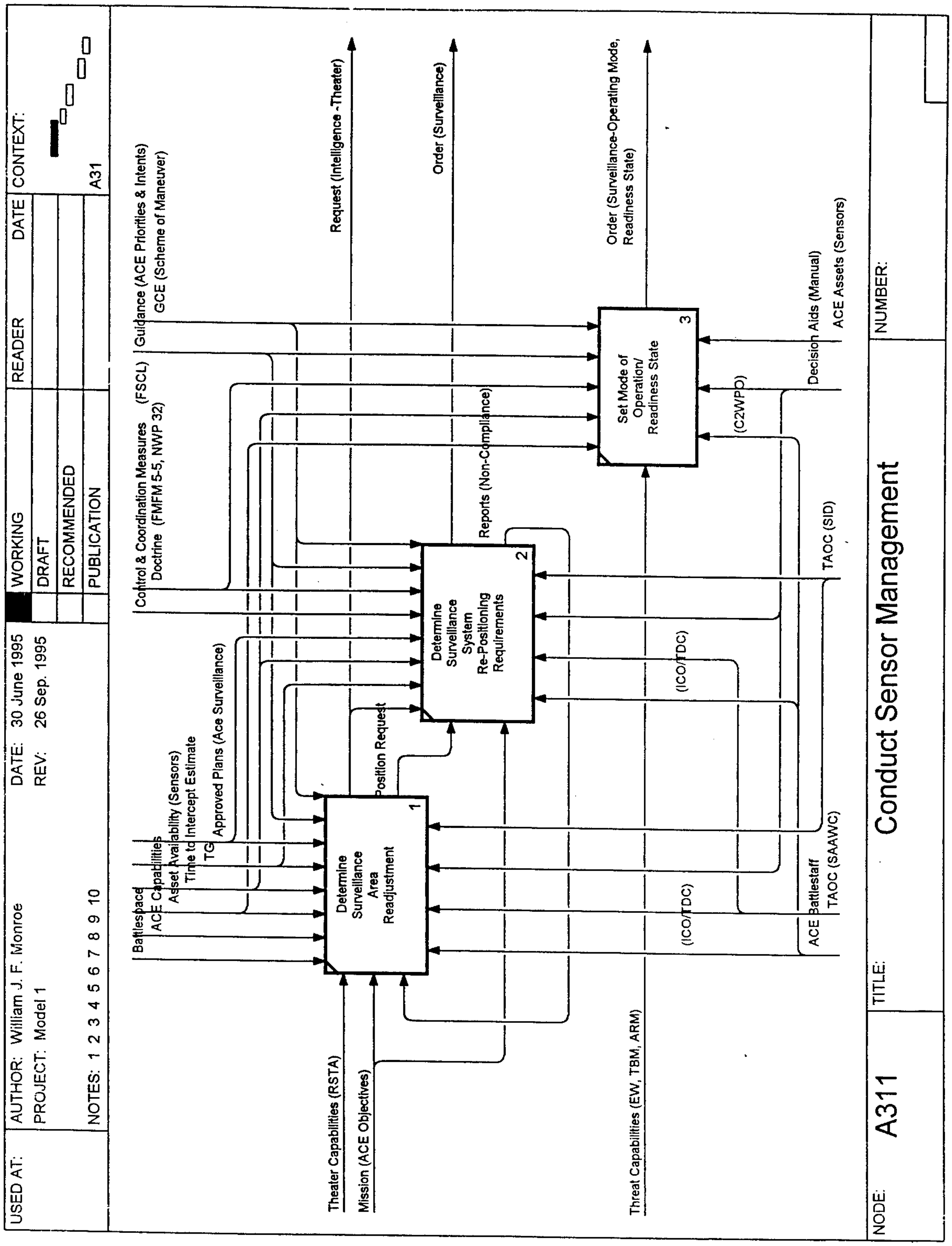

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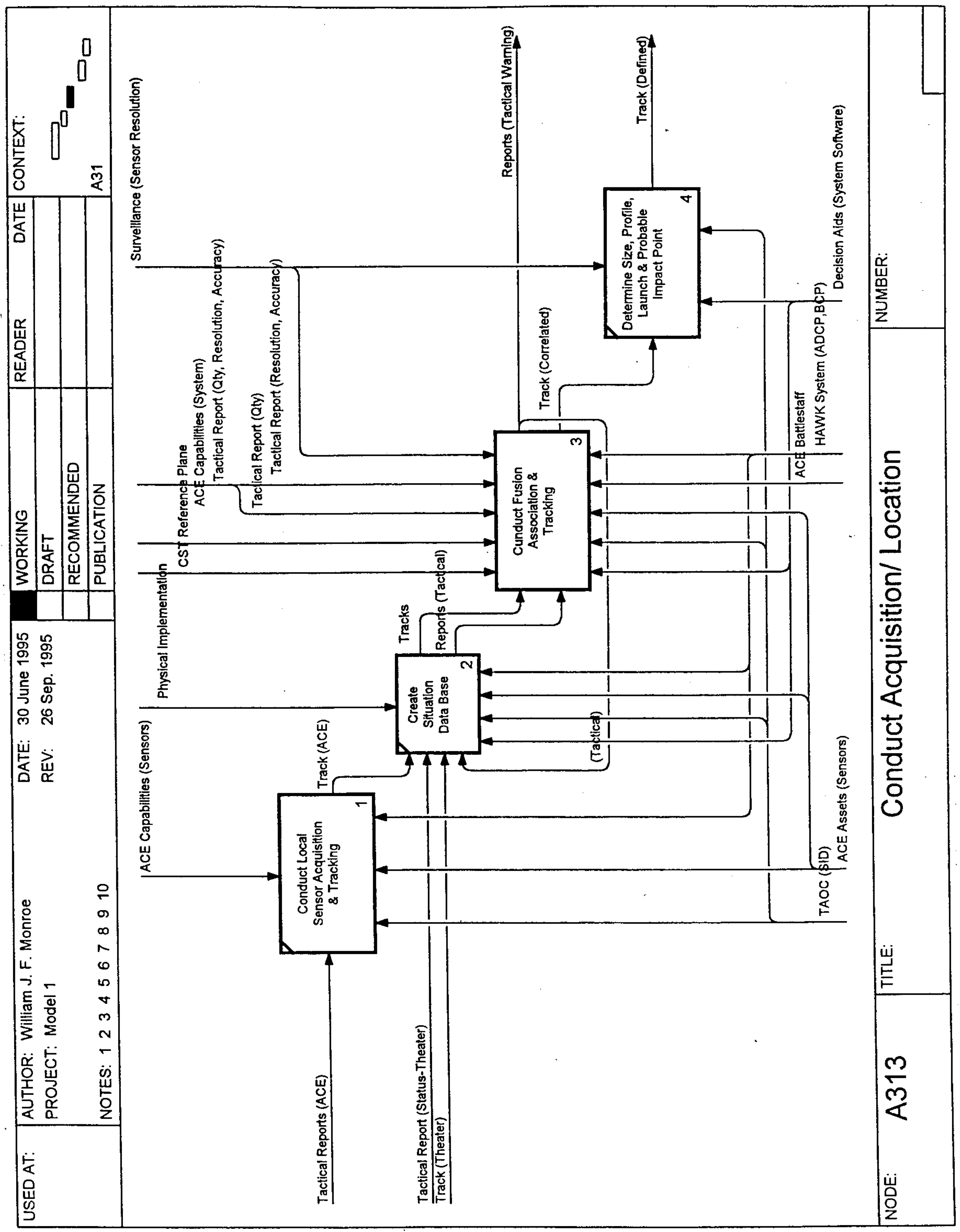

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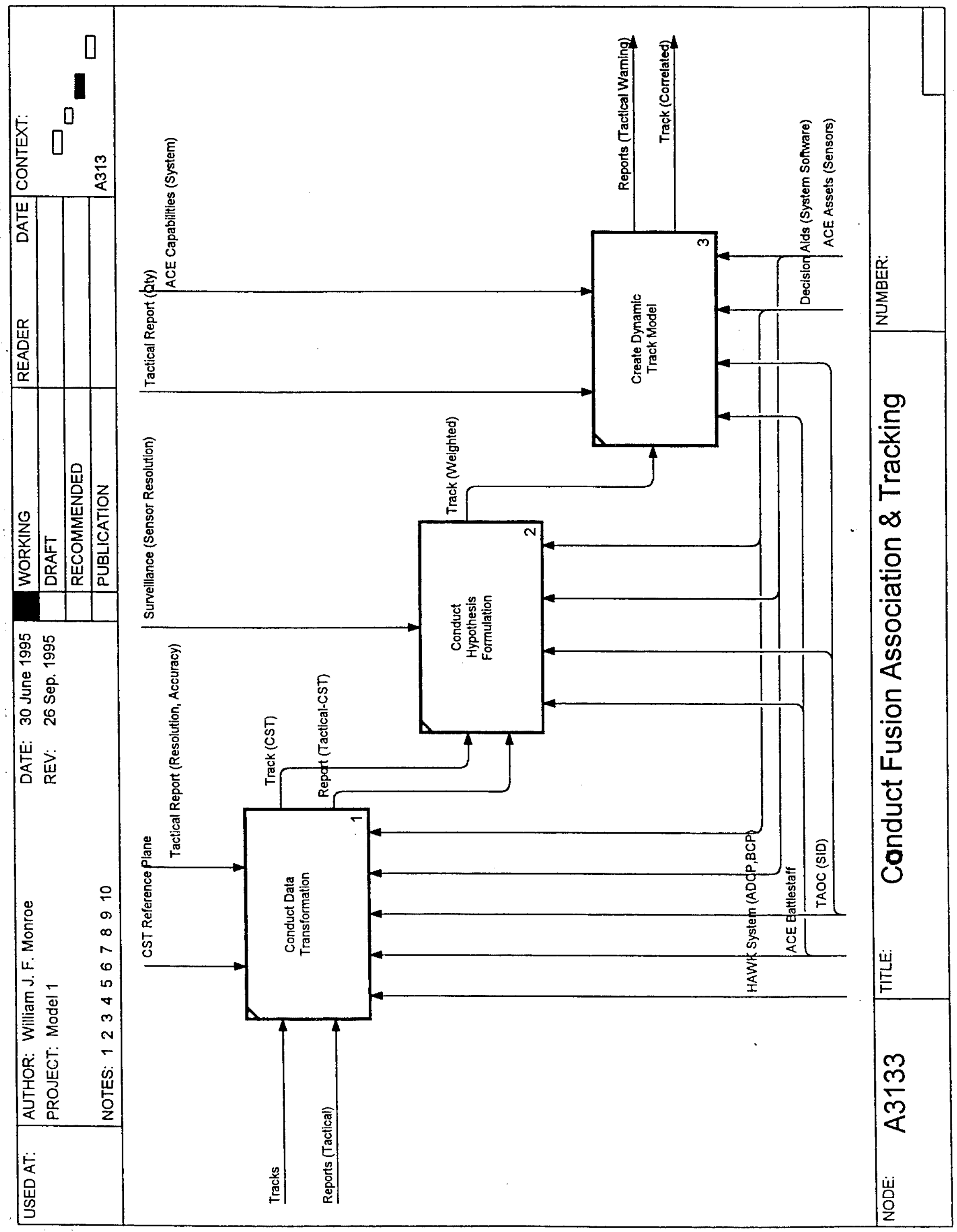

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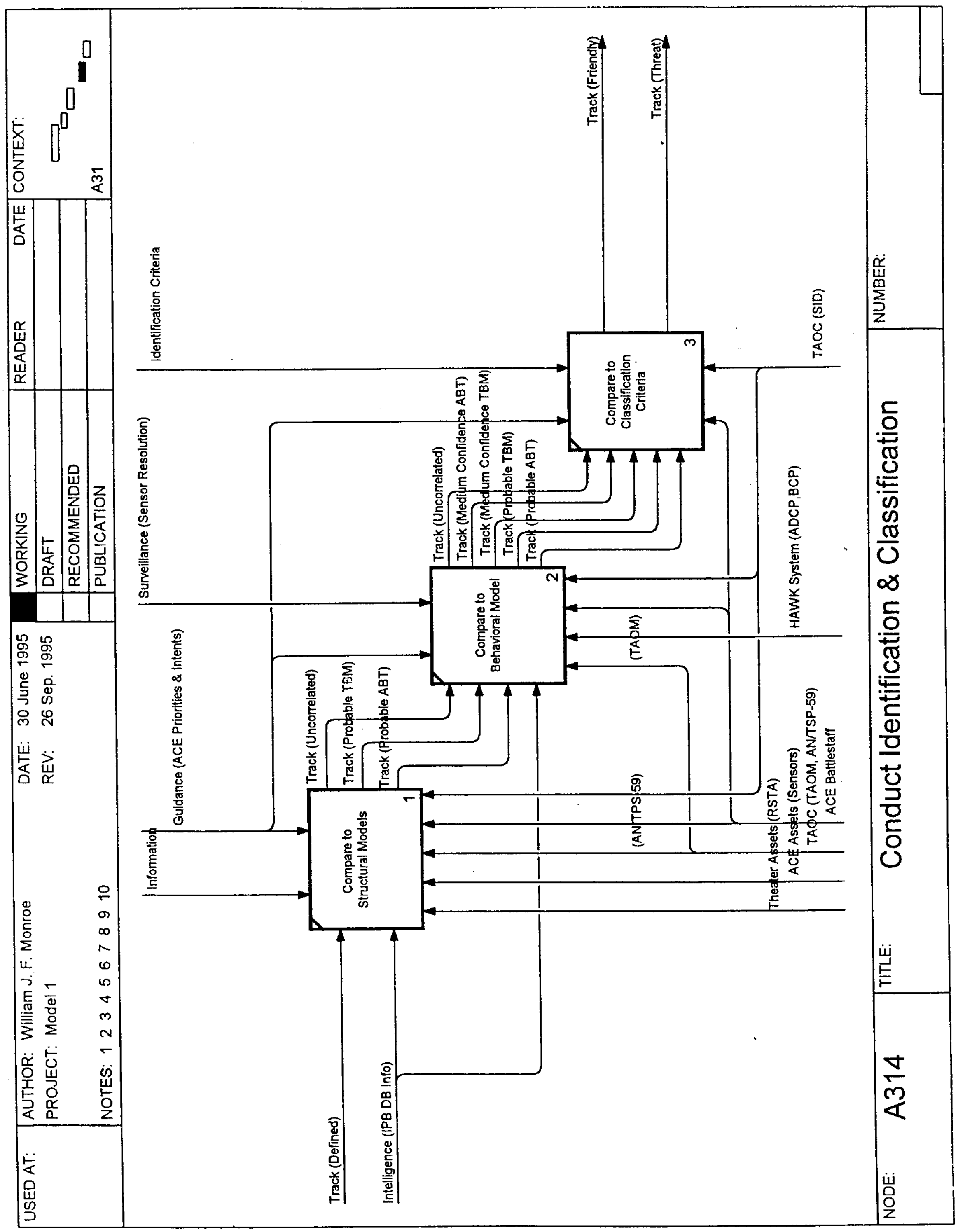

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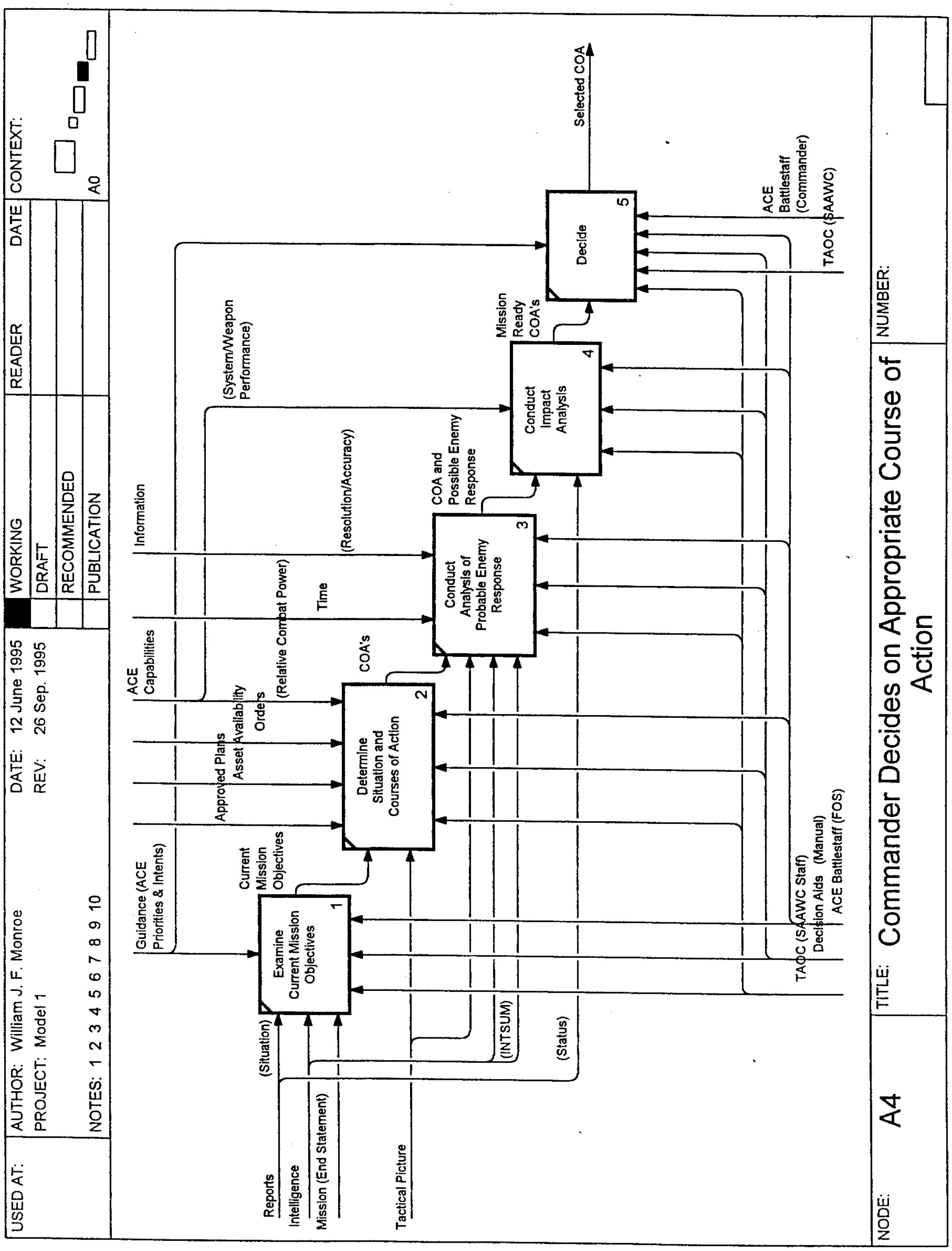

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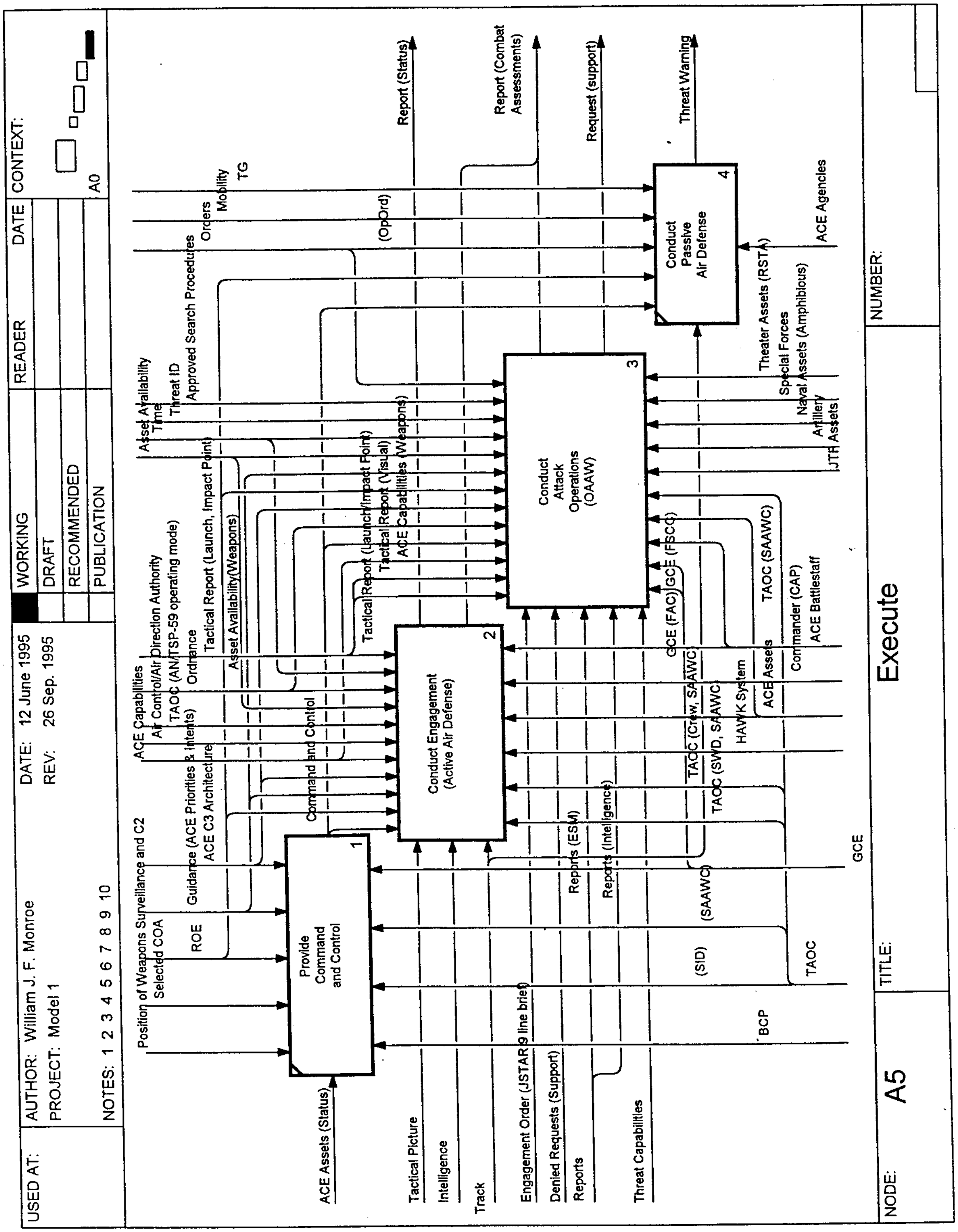

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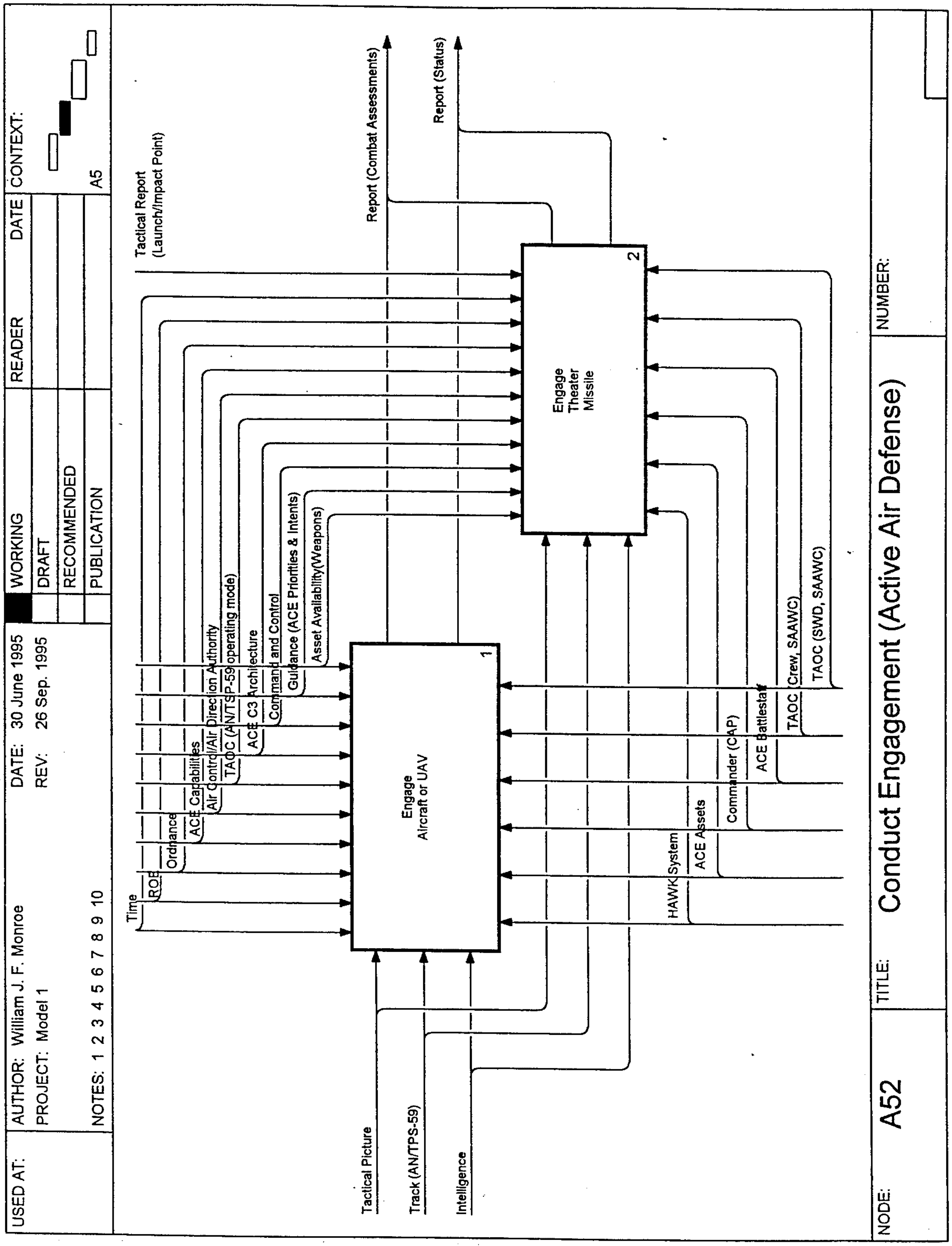

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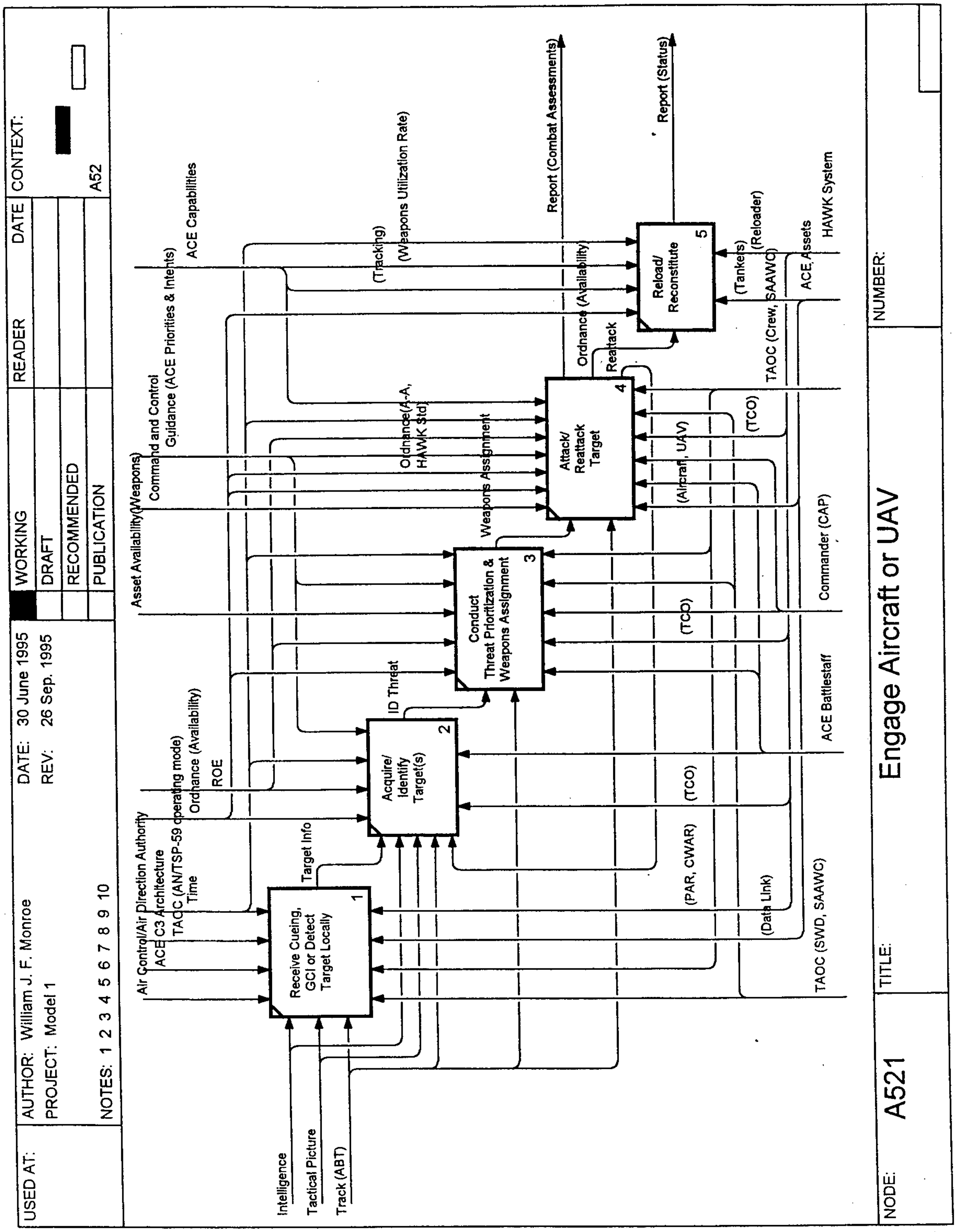

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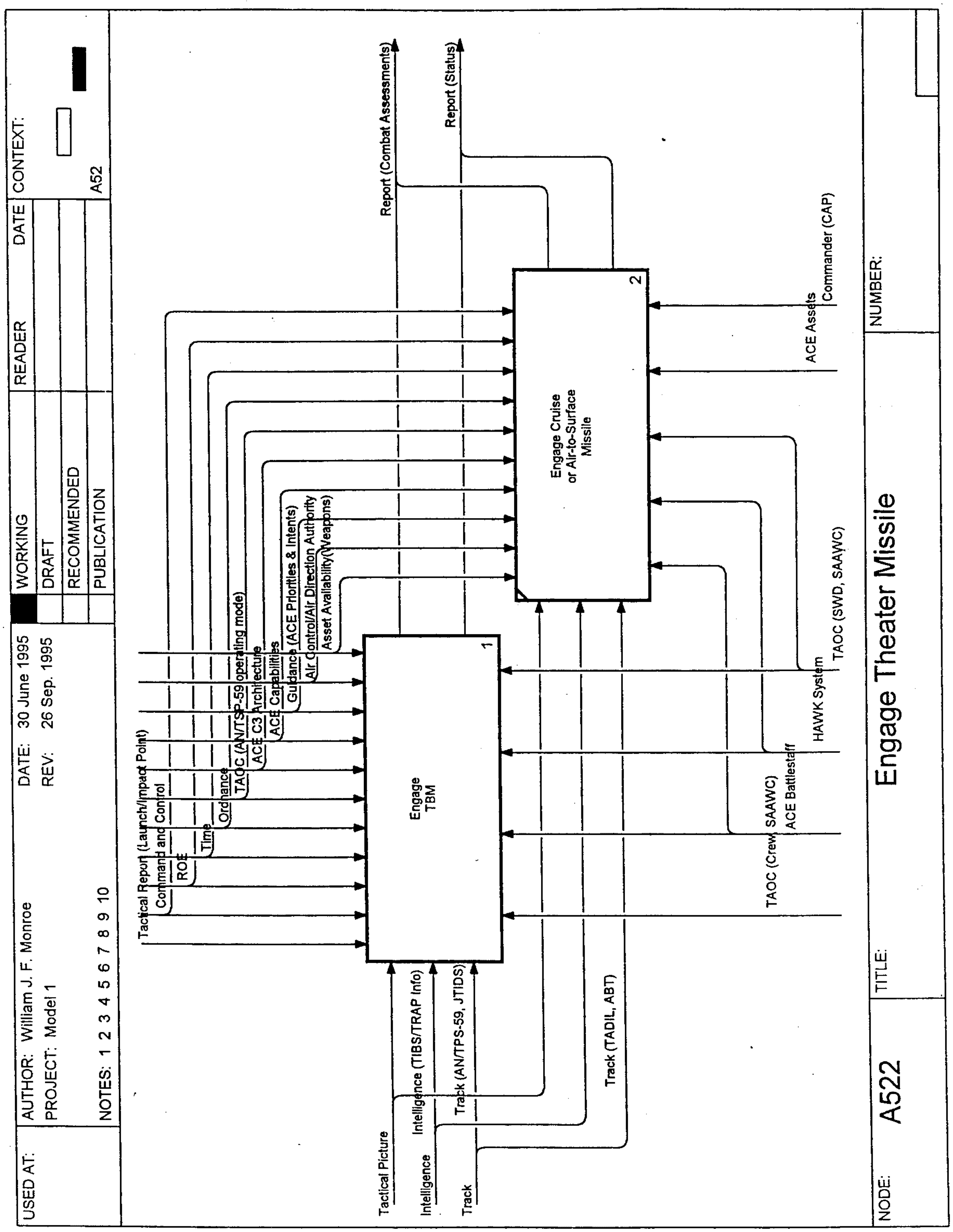

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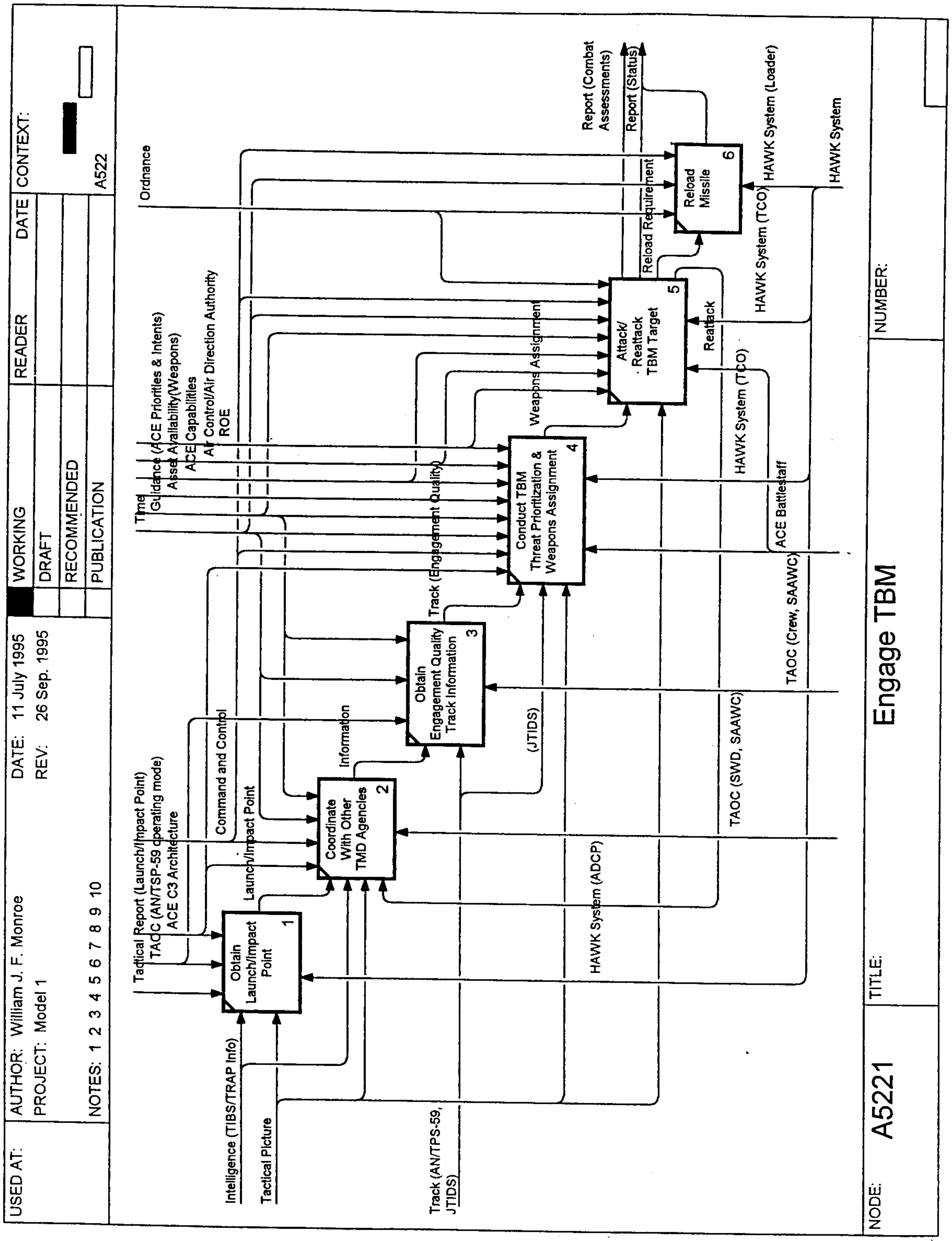

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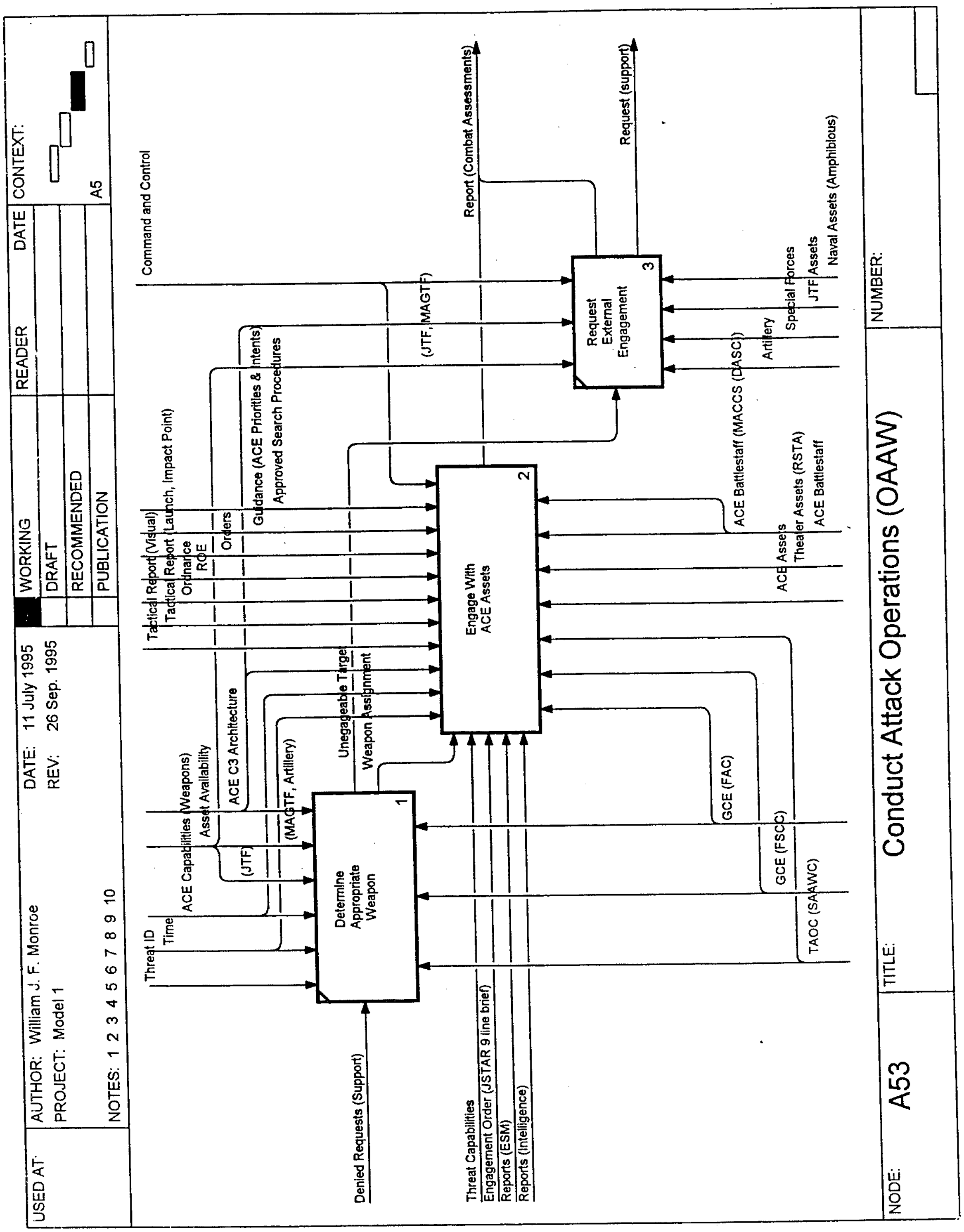

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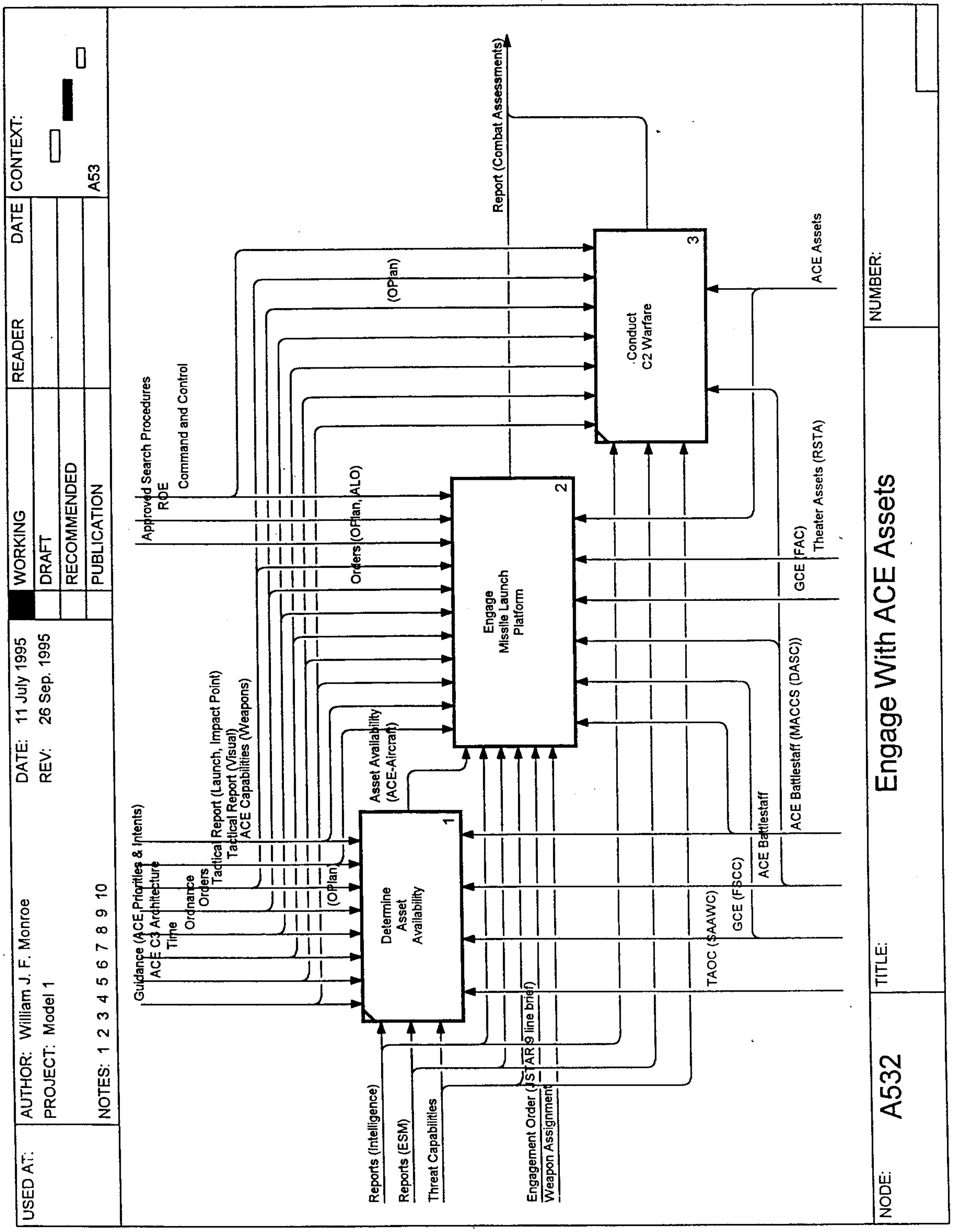

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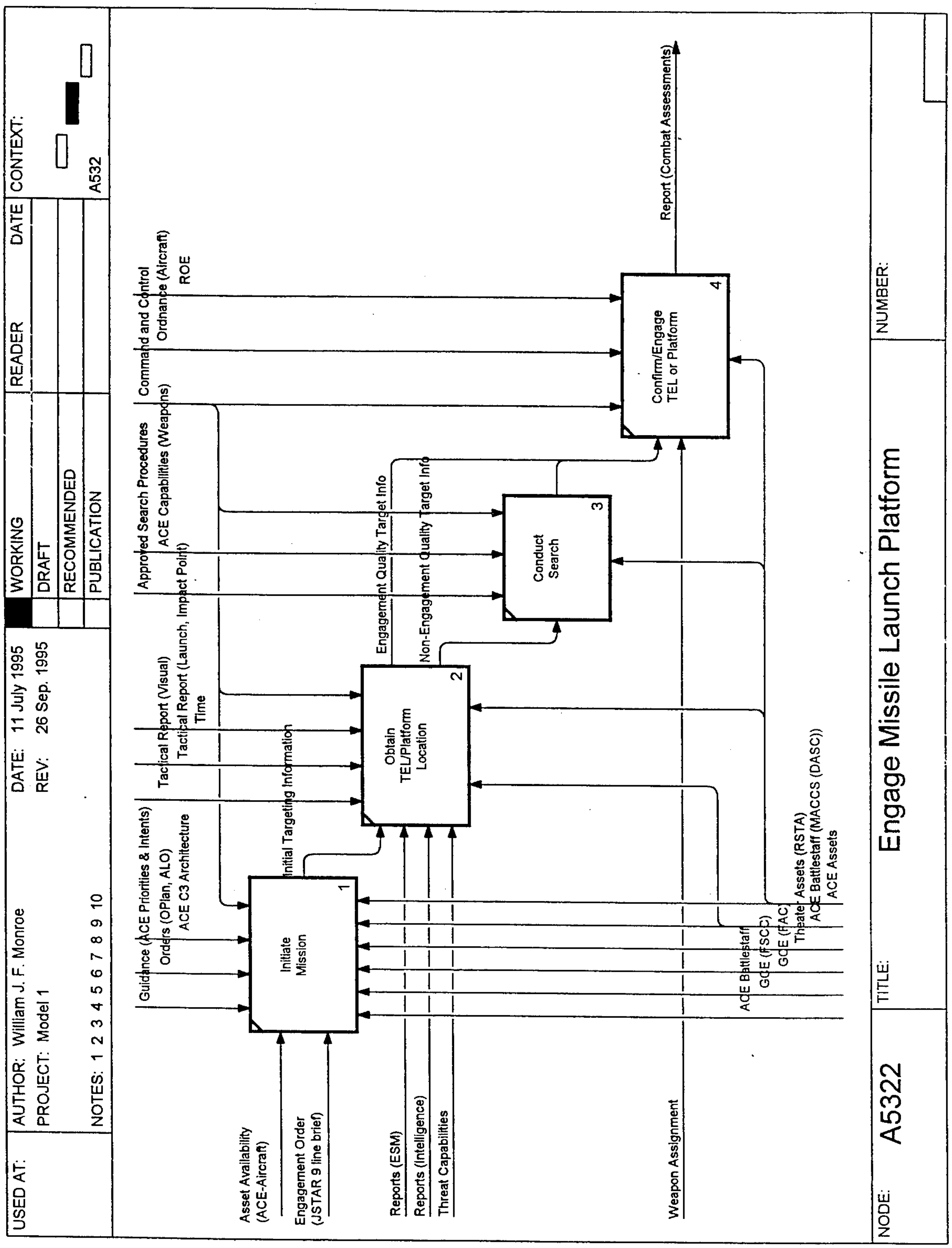


Figure B.2 (Continued)

APPENDIX C. ACTIVITIES DEFINITIONS

Casualty Procedure Options: A1.4.3 Prescribing alternate agencies. In an air defense environment, provisions are made in case of operational failure of the TAOC either from enemy action or system malfunction. Failures must not disrupt the continuity of air defense operations and some system degradation must be anticipated during planning to provide alternatives. In lieu of establishing a duplicate TAOC within a sector, proper planning will ensure air defense functional continuity. This preservation requires significant decentralization of authority as well as imposing some operating restrictions on friendly aircraft. Local standing operating procedures (SOP's) will establish the specific procedures and relationships for decentralized operations. The EW/C and AEW/C facilities may assume some of the functions of a TAOC. Since each of these facilities possess the same basic capabilities, they are considered equally suitable as alternate facilities for performing some TAOC functions. Long-range surveillance capabilities will vary with each configuration, but these facilities do offer the MAGTF continuity of this vital function. Further, these facilities also offer an alternate means of control for interceptor aircraft. AEW/C aircraft allow semiautomatic data exchange with the TAOC and reduce the requirement for the degree of decentralization necessary with a manual EW/C facility. However, where both operational modes are concerned, saturation occurs more quickly, coordination with missile systems is indirect, and the general level and quality of management is greatly reduced. (FMFM 5-5)

Conduct Acquisition/Location: A3.1.3 Activity related to fusing track and report information. Information is received from many sources, in many different mediums, and formatted differently. Fusion is the logical blending of information from multiple sources into an accurate, concise and complete summary. The goal of performing fusion is to reduce information to the minimum essentials, put it in a form that Marines can quickly act on, and produce a common situational awareness that is accurate and meets the needs of the commander and subordinate leaders. Properly fused and displayed information, at the right time and place aids the commander in overcoming uncertainty. (FMFM 3, section 3003) Fusing the information used in TBM detections may not totally be possible, but at a minimum, a confidence level must be assigned to assist the commander in associating the numerous types of tactical reports. In some cases, the classification level of the sensor may exceed the operators clearance level. In this case, the information must be transformed into a for that is appropriate and usable.

Conduct Analysis of Probable Enemy Response: A4.3 Activities related to the determination of the probable effect of each enemy capability on the success of each of the commander's own course (s) of action. (AFSC Pub 1)

Conduct Antiair Warfare Operations: A0 Antiair warfare (AAW) is the action that is required to destroy or reduce the enemy air and missile threat to an acceptable level. It

includes such measures as the use of interceptors, bombers, air-to-air and surface-to-air Weapons (SAW's), electronic countermeasures (ECM), and the destruction of the aircraft or missile threat both before and after launch. Other AAW measures which are taken to minimize the effects of hostile air action are cover, concealment, dispersion, deception (including electronic deception), and mobility (FMFM 5-5). The term "Theater Missile (TM)" applies to ballistic missiles, cruise missiles, and air-to-surface missiles whose targets are within a given theater of operation. The term "Theater Missile Defense (TMD)" applies to the identification, integration, and employment of forces supported by other theater and national capabilities, to detect, identify, locate, track, minimize the effects of, and/or destroy enemy Tms. This includes destruction of TMs on the ground and in flight, their ground-based launchers and supporting infrastructure; TM-capable ships and vessels in port or at sea; and enemy aircraft armed with air-to-surface missiles. TMD operations are accomplished by integrating a mix of mutually supportive passive defense, active defense, attack operations, and C4I support measures. (Joint Publication 3-01.5) It has been determined that TMD fits into the Marine Corps implementation of AAW as indicated in the below areas. (Air Control /Air Defense Doctrine Officer, MCCDC Letter 3000, c423, 8 April 1994) Active Air Defense Activities related to defense measures designed to destroy attacking aircraft or missiles in the earth's envelope of atmosphere, or to nullify or reduce the effectiveness of such an attack. For TMD, Active air defense applies to operations initiated to protect against a TM attack by destroying TM airborne launch platforms, and/or destroying TM's in flight. Active defense includes multitiered defense in depth via multiple engagements using air, land, sea, space, and special operations assets. It also includes active EW to disrupt remote or on-board guidance systems. (Joint Publication 3-01.5) Offensive AAW Activities related to operations conducted against enemy air assets and air defense systems before they can be launched or assume an attacking role. Offensive AAW operations in or near the objective area consist mainly of air attacks to destroy or neutralize hostile aircraft, airfields, radars, air defense systems, and supporting areas. (FMFM 5-5) For TMs, Attack operations apply to operations initiated to destroy, disrupt, or neutralize TM launch platforms and their supporting command, control, and communications (C3); logistic structures; and reconnaissance, surveillance, and target acquisition (RSTA) platforms. Attack operations include offensive action by air, land, sea, space and special operating forces. (Joint Publication 3-01.5) Passive Air Defense Activities related to actions taken to minimize the effects of hostile air action, they include: cover, concealment, dispersion, deception (including electronic) and mobility. (FMFM 5-5) For TMs, passive defense applies to measures initiated to reduce vulnerability, and to minimize the effects of damage caused by TM attack. Passive defense includes TM early warning and NBC protection, Countersurveillance, deception, camouflage and concealment, hardening, electronic warfare, mobility, dispersal, recovery and reconstitution. Passive Air Defense for TMs also can include training civil authorities to organize and instruct their populations on actions to take upon warning of missile attack. (Joint Publication 3-01.5)

Conduct Attack Operations (OAAW): Activity Definition: A5.3 Conduct Attack Operations (OAAW) Activities related to operations initiated to destroy, disrupt, or

neutralize TM launch platforms and their supporting command and control, and communications (C3); logistics structures; and reconnaissance, surveillance, and target acquisition (RSTA) platforms. Attack operations include offensive action by air, land, sea, space, and special operating forces (SOF). (Joint Publication 3-01.5)

Conduct C2 Warfare: A5.3.2.3 Activity related to implementing the integrated use of Operations security (OPSEC), military deception, psychological operations (PSYOP), electronic warfare (EW), and physical destruction, mutually supported by intelligence, to deny information to, influence, degrade or destroy adversary capabilities, while protecting friendly C2 capabilities against such actions. C2W is both offensive (Counter C2) and defensive (C2-protection). (CJCS MOP No. 30 dated 8 Mar 1993) (Meeting with MAWTS-1, 18 May 1994) C2W is employed against an enemy's C3 surveillance and target acquisition to disrupt TM operations. This will influence, degrade or destroy the enemy C2 Capabilities and is closely linked to passive defense measures of deception. The primary goal is to blind the enemy and thereby enhance overall protection of the force. (Joint Publication 3-01.5)

Conduct Data Transformation: A3.1.3.3.1 Before a comparison can be mad, detections (reports) and tracks (from sensors which maintain local track files or reports that have been associated with other reports that are of the same event) must be associated in time and space to assign sensed data to individual target files. Because the reports and tracks arrive from sensors with differing geometries.

Conduct Identification & Classification: A3.1.4 Activity related to determination of the tactical reports identification as a friend or foe and what type of weapons platform that it is. Once determined, the track or report is classified with the appropriate category . The TAOC, due to its air defense design, is the focal point for all such activity and is also the point of primary evaluation of the various inputs. An examination of the internal tasks of the TAOC should effectively illustrate the rationale behind the preceding discus-sion. The surveillance identification section provides detection, acquisition, and identification of all unknown targets within the assigned air defense sector. Subsectors are assigned according to the specifies of the situation, and surveillance is accomplished within these sub sectors. For this task, operators employ the radar organic to the TAOC as well as surveillance reports from SAW and EW/C radars. "Unknown" contacts are forwarded by these sources for the application of identification criteria by the Surveil-lance Identification Director. Altitude information is confirmed. Then, flight plan correlation, use of friendly corridors, and aircraft flight characteristics are applied to the contact to provide identification. Should all of these methods fail to produce positive identification, the track is designated as unknown. (FMFM5-5) Within the processes of any air defense system, the starting point for all operations is detection/identification. This is most critical and must be rapidly accomplished at a reasonable range. The destruction-in-depth deployment of weapons allows some margin of flexibility in the engagement process, but the speed capabilities of in-coming enemy aircraft reduces flexibility in the time allowed for identification. The system must provide

for rapid and positive identification through clear-cut assignment of identification responsibility. The most effective measures designed to provide timely identification include positive radar control, visual control, flight plans, IFF, and air corridors. A detailed discussion of these measures is found in NWP 32. Another method employed in the various identification processes is identification by flight characteristics. In effect, however, this method more often determines hostile rather than friendly targets. In many instances, the observed movement of an air contact may be presumed hostile if out of character with local air activity. Some examples are: Low-level, high speed, approaching targets detected by SAW units may be presumed a hostile because close air support delivery maneuvers are not of long duration on a consistent inbound heading, inbound aircraft speeds are slower close to the vital area due to the density of aircraft, and whenever marginal communications exist, CAP pursuits are broken off well before the crossover point. An unidentified air contact maneuvering for attack position on friendly aircraft should be presumed hostile as all friendly interceptor aircraft will be under positive control. The flight characteristics of an aircraft maneuvering for an advantageous position for air-to-air engagement are obvious to a radar observer and relative positions of other friendly fixed-wing aircraft are immediately available. The third and most obvious type of flight characteristic providing hostile air identification is the commission of a hostile act observed by any friendly force clement. Below is a discussion of identification sources, Tracking.

a. Identification Sources: In an active air defense environment, the indicated agencies are responsible for securing and maintaining the friendly identification prescribed below:

(1) Positive Radar Control: The TAOC is the initiating agency for air defense action and is the source of most positive control information. It controls CAP aircraft, provides flight following, and exchanges mutual interest track information with adjacent air defense agencies. The traffic control section performs the TAOC's most reliable identification process-positive control of friendly aircraft. All operating fixed-wing aircraft transiting the sector or not otherwise under control of another MACCS element are processed through the TAOC. The TAOC traffic control task is performed by one or more weapons control teams as permitted by the air defense alert condition. Subsectors are assigned these weapons control teams to allow for concentration of effort and to assist recall. En route friendly aircraft are received by these teams, identified, designated, and either vectored or monitored as they proceed with their mission. If the mission requires control by another agency, aircraft are released but will be required to report back for recovery and reclassification. Aircraft reporting in/out procedures are found in FMFM 5-1. Not only is safety served by this process, but ideally, all fixed-wing aircraft are under active control/monitoring at all times. This control/monitoring allows rapid comparison of the warning section reports to known position information. These operators also query agencies external to the TAOC concerning their positive control information. Should internal data not allow correlation, an attempt is made by the traffic controller to correlate positive control position information from other agencies such as the DASC or Marine air traffic control

squadron. If time and target speed allow, correlation will be attempted before initiating any engagement. This process is vital not only for friendly aircraft safety but also for air traffic manage-ment. It should also be obvious that as sector aircraft density increases, less time will be available for the TAOC to individually query each positive control agency. The TAOC is not, however, an exclusive source of positive radar control information and requires supplementary information from the MATCS. The aircraft status on radar controlled departures and approaches is maintained by the MATCS. The MATCS additionally maintains the status of aircraft in holding patterns. The TAOC is kept informed of the status of aircraft under MATCS control and those aircraft anticipated to report for air traffic control purposes which are penetrating the sector.

(2) Visual Control: The only consistent sources of visual identifica-tion of friendly fixed-wing aircraft are LAAD teams and terminal close air support (CAS) control agencies or observers such as the forward air controller (FAC), TAC(A), or air observers (AO). These agencies, with the exception of the additional duty LAAD teams of the LAAM battalion, operate through the DASC. Therefore, the DASC is responsible to furnish the TAOC with position information on these aircraft and on any aircraft under the visual control of these terminal agencies.

(3) Flight Plan Information: The sources of flight plans are aircraft crews assigned missions by the daily fragmentary order, aircraft crews on routine flights, and aircraft crews departing or entering the air defense sector. Flight plans are filed with the appropriate air traffic control center (ATCC), including any designated en route ATCC. Sector ATCC's receive and forward to the TACC/TAOC flight plan information as prescribed. At the discretion of the TAC, the ATCC may directly forward these to the TAOC, which then advises the TACC. For aircraft departing or entering the sector, adjacent ATCC's exchange flight plan data of mutual concern. Verbal flight plan information is recorded and retained by the receiving agency and promulgated as necessary.

(4) Identification, Friend or Foe/Selective Identification Feature (IFF/SIF): Due to its nature, this identification data requires different handling than other types. IFF/SIF information is only available to agencies possessing the equipment required to provide electronic challenge. Such a capability is found in the TAOC, BCP, and MATCS. When applicable, IFF/SIF modes and codes accompany initial position reports from these units.

(5) Air Corridors: Identification of aircraft within air corridors is obtained through radar surveillance and the exchange of flight information between adjacent and internal air defense sector control agencies. Corridor boundaries are maintained by all concerned agencies.

(6) Flight Characteristics: Any agency which identifies hostile aircraft by their flight characteristics will immediately report this information, with the status of any

initiated engagement, to the TAOC. Ground units, LAAD teams, FAC's, etc., report through the DASC. TAC(A)'s, helicopter coordinators (airborne) (HC (A)'s), AO's, and other aircraft report directly to the TAOC when possible by appropriate air-to-ground communications. LAAM batteries and early warning and control (EW/C) sites report directly to the TAOC.

b. Surveillance/Traffic Monitoring: Once initial radar detection has been made, the air defense control agency requires a means of maintaining the changing position of the radar contact. It is additionally necessary to keep abreast of the move-ments and intentions of friendly aircraft operating within the objective area. For this purpose, surveillance operator traffic controllers, and weapons controllers are stationed in the TAOC.

(1) Surveillance: The TAOC establishes radar-detected tracks through its surveillance system. Upon detection, the identification process begins and each friendly control is identified by appropriate category. The contact is assigned symbology and the system automatically updates its position. Depending on the degree of threat and the volume of traffic, surveillance is conducted by assigning a surveillance operator to each subsector. Thus, detection, identification, and symbology assignment are performed. The surveillance capacity of the TAOC is limited by the detection capability of the input radars.

(a) TADILS: The TADILS have been designed to develop and exchange digital data on a variety of air matters. The information of concern to the MACCS is the position and identification data on aircraft operating under the cognizance of naval air control agencies. In this manner, an aircraft passing through a sector or flying in a sector overlap area is identified with current and accurate position information. Two-way exchange of information between the MACCS and NTDS/ATDS is possible and is made through the Marine tactical data communication central (TDCC), normally employed with the TACC and TAOC.

(b) SAM Acquisition: In addition to visual acquisitions by LAAD teams which are relayed to the TAOC through the DASC, the coverage of TAOC radars has been supplemented in the shorter range, low to medium altitude radar envelope by the acquisition radars of the Hawk system. This coverage product is relayed to the TAOC for initial identification and/or identification confirmation.

(c) Other Agencies: Provisions are also made by the TAOC to allow surveillance input from other radar sources, such as airborne or ground gap-filler radar facilities.

(2) Track Monitoring: Once traffic is detected and identified as friendly, they are passed to a TAOC traffic controller whose function is to provide flight following navigational assistance, and altitude separation from other air traffic. Traffic controllers are normally assigned geographic subsectors in which they maintain accurate and timely situation data on all friendly aircraft. Their tasks include control of aircraft reporting for

flight following. These personnel assist the surveillance effort by sustaining timely information on targets already processed for identification. Weapons controllers are responsible to ensure current track status on interceptor aircraft under control. When CAP stations are not actively manned, weapons controllers may function as additional traffic controllers (FMFM 5-5) Examples of Track Classification. The definitions of track classifications herein are general and must be specifically defined by the tactical air commander to conform to the tactical situation. CONFIRMED HOSTILE; any track positively determined to be hostile. ASSUMED HOSTILE; any track whose hostile identity has been assumed in accordance with the criteria established by doctrine or the tactical situation. Efforts to positively identify continue. UNKNOWN; the identity assigned to all tracks whose intent cannot be determined by criteria or doctrine as being either hostile or friendly. ASSUMED UNKNOWN; an identity automatically assigned to all new tracks which indicates that the track has not been considered by the TDS identification officer. ASSUMED FRIEND; any track whose friendly identity has been assumed in accordance with the criteria established by doctrine or tactical situation. Efforts to identify positively continue. CONFIRMED FRIEND; any track which has been positively identified as friendly. The TAOC, as previously indicated, is the agency responsible for requesting, receiving, and coordinating the various identification inputs, maintaining the appropriate aircraft classifications, and responding to queries made by defensive weapons systems by back-tell. As the focus of the sector air defense system, it must anticipate specific input requirements from associated air control elements and recommend appropriate tasking. It is further responsible to anticipate and recommend alternate procedures to preserve air defense continuity should its systems become degraded or inoperative. (FMFM 5-5)

Conduct Local Sensor Acquisition & Tracking: A3.1.3.1 Activity representing the function of a tracking radar that detects a target and begins to build a track history. The AN/TPS-59 radar accomplishes this task in the TBM or Combined mode of operation.

Conduct Passive Air Defense: A5.4 Passive AAW operations are employed by all elements of the MAGTF and are designed to minimize the effect of hostile air action. Passive operations include cover and concealment, dispersal of forces and installations, deception (including electronic deception), shielding, damage control provisions, and exploitation of the mobility of an expeditionary force. Considerations may also be given to assisting HN or allied civil authorities in establishing passive defense measures for the civilian population and HN assets, consistent with the overall mission. (Joint Publication 3-01.5) Cruise missiles often require photos for the last 2 to 5 miles of the target (friendly locations). Altering the area with camouflage or moving equipment can assist in moving shadow angles or totally denying an opportunity for an enemy to obtain the necessary photos.

Conduct Planning: A1 Planning must implement the commander's vision and lay the foundation for future decisions and tasks. Planning normally begins with the receipt of a formal mission or the commander's understanding of an implied task based upon informal communications with higher headquarters. Essential information that supports the mission

is gathered and a thorough analysis is performed to determine an appropriate coarse of action. (FMFM 3, section 3005) This identifies one planning cycle. The ACE commander plans and prosecutes air operations using combined arms to support the MAGTF commander's plan. Air operations include close operations designed to apply power projection decisively against enemy forces that pose an immediate or near term tactical threat. Air operations can also include deep and rear operations. The MAGTF commander may designate the ACE as his main effort. The ACE is the MAGTF's primary fire support means. (FMFM 5-60) Based upon an analysis of doctrine, AAW Planning is a dynamic process in which many of the activities are interrelated requiring them to be developed concurrently. For example, the size and scope of the battlespace is determined, in part, by the time-to-intercept estimates which are associated with weapons and control capabilities. The required weapons and control requirements are dependent on the battlespace. Normally the AAW planning is conducted in the plans section of the TACC and involves activities related to evaluating the status of current identification, the track is designated as unknown.

Define & Bound Battlespace: A1.3 Activities related to determining the battlespace organization which is the way naval expeditionary force commanders visualize how they are going to fight the enemy and structure the command and control to ensure victory. Battlespace is an area of operations viewed in three dimensions: air/space, surface and subsurface. The commander relates his forces to each other in terms of sea, air and land operations and to the enemy in terms of time. The Commander must know not only the location of the enemy, but how fast the MAGTF can react to the enemy=92s initiatives and how fast the enemy can react to the MAGTF. (MACCS Tactical Planning, section 2005) The ACE follows this same methodology with more emphasis on time since air assets can employed/re-employed very quickly. For the ACE this process includes determining the ACE Area Of Operation and the Area Of Interest. The AO is the area that the ACE is responsible to provide AAW support for. The AOI is the area that the ACE must provide surveillance for and it may extend beyond the bounds of the AO. It will generally be determined based upon the terrain, sensor capabilities, threat capabilities and support for the ACE mission.

Define & Bound Mission: A1.2 Process related to clearly defining the AAW Mission and its Boundaries. It is important to go beyond the battalion or squadron mission and to analyze the ACE and MAGTF. Also analysis will be conducted on the ACE and MAGTF Commander's intent and Concept of operations. This provides insight into their vision for success on the battlefield and how they see the battle unfolding. It will also provide an appreciation for the overall scheme of maneuver. Most importantly, it will facilitate deriving the specified and implied tasks which will be crucial in the accomplishment of the assigned mission. This process includes determining any assumptions that have been made. (MACCS Tactical Planning Guide) During mission analysis, the commander assesses the total situation, builds his vision of the battlespace, and projects the desired outcome of the battle or campaign. Mission analysis is conducted by the commander and all members of the staff. a thorough mission analysis identifies the following: Higher commander's intent,

Specified task(s), Implied task(s), Limitations (constraints and restraints), Critical vulnerability (What will make the enemy unwilling or unable to fight? What is critical to the MAGTF's success), and Center of gravity. (FMFM 3, Section 3005)

Define Boundaries of ACE AO: A1.3.2 The AO is a defined area of land in which responsibility is specifically assigned to the commander of the area for development and maintenance of installations, control of movement and the conduct of tactical operations involving troops under his control along with parallel authority to exercise these functions. (Joint Pub 1-02, (part 1 of 2 part definition) and FMFM 5-60, p. E-8) For the ACE this translates to the process of determining the size of the AO, the Airspace Control Area, Air Defense Area, and Sectors Of Responsibility. (MACCS Tactical Planning Guide)

Define Boundaries of ACE AOI: A1.3.3 Activity related to determining the area of concern to the commander, including the area of influence, areas adjacent thereto, and extending into enemy territory to the objectives of the current planned operations. This area also includes areas occupied by enemy forces who could jeopardize the accomplishment of the mission. (Joint Publication 1-02, and FMFM 5-60, p. E-8)

Determine ACE Commander's Priorities & Intent: A1.2.4 Activity related to determining the ACE Commander's priorities and intent. The commander's priorities for the TMD effort, for example, might be: what type of targets are most important for attack operations and what friendly assets must be protected by active air defense. (Joint Publication 3-01.5) The ACE Commander's intent is a clear, concise statement that defines success for the force as a whole by establishing, in advance of events, the battle or campaign's desired end state. It stimulates the entire planning process, unifies the force toward a common mission objective, and provides subordinate commanders with a way to gauge freedom of action. The commander's intent contains: the purpose of the operation, the critical vulnerabilities and centers of gravity for both enemy and friendly forces, a vision of how the operation will be conducted in a broad scope. A description of the end state with respect to the relationship of the force, the enemy, and the terrain. A description of how the end state will facilitate future operations. (FMFM 3, section 2001) The Commander's vision for success includes the focus of the main effort and potential friction areas, identified strengths the must be exploited to ensure success, vulnerabilities in our defense the threat may attempt to exploit and finally a definitive mission statement. The overarching purpose of this intent is to provide subordinates the necessary guidance with which to execute the plan while providing ample room for individual initiative in the absence of further input. (MACCS Tactical Planning Guide)

Determine Air Control Air Direction Authority: A1.4.1.1 Air Control is the authority to direct the physical maneuver of aircraft in flight or to direct an aircraft or SAW to engage a specific target. An air controller performs air control when he maneuvers an aircraft by directing the pilot. A missile controller performs air control when he directs a SAW to engage a particular target. (FMFM 5-60) Air Direction is the authority to regulate the

employment of air resources (aircraft and SAW units) to maintain a balance between their availability and the priorities assigned to their use. The purpose of air direction is to achieve a balance between the MAGTF=92s finite aviation assets and the accomplishment of the ACE's mission. Air direction tasks include, but are not limited to: development of ATOs, fulfilling the requirements of ATOs (tasking aircraft to perform specific missions), changing or altering an aircraft's mission, processing air support requests, collecting information concerning mission status, moving Ground-based air defense fire units to new firing positions, and adjusting aircraft/SAW unit mission assignments within previously set parameters due to changes in the air or ground situation. (FMFM 5-60) Below is a table outlining the agencies normally assigned Command, Control, and Air Direction authority within the MACCS. (FMFM 5-60, p. 2-2)

						TACC	TADC	TAOC	DASC
MATCSEW/C		TAC(A)FAC		FAC(A)	ASC(A) COMMAND	X			
				AIR CONTROL		X	X	X	X
X	X	X	X	POSITIVE CONTROL		X		X	X
			PROCEDURAL CONTROL			X	X	X	X
X	X	X	X	RADAR CONTROL		X		X	X
			TERMINAL CONTROL		X	X	X	X	XX
	X		AIR DIRECTION		X			X	X
	X								

Determine ACE Objectives & AAW Integration: A1.2.3 This activity is completed in close association with the MAGTF planning staff. Once the ACE Commander has determined how the ACE will support the MAGTF scheme of maneuver, he will then determine the rough order of magnitude of AAW operations required.

Determine Appropriate Weapon: A5.3.1 Activity related to determining what weapon or C2W strategy would be appropriate to engage the TEL or Missile Platform. The determination is made if the ACE, MAGTF or the JTF assets would be more appropriate.

Determine Asset Availability: A5.3.2.1 Activity related to determining the availability of Artillery, Aircraft, or SOF. Artillery call for fire is placed with the FSCC. An Aircraft destined for a CAS mission may be diverted to an OAAW mission once coordinated with the FSCC.

Determine Combat Service Support Requirements: A1.5.5 Activities related to the CSSE commander planning for operations that will provide essential logistics functions, activities , and tasks that support and permit force sustainment.

Determine Degree Of Air Superiority Required/Desired: A1.5.1 Activity related to determining the level of localized air superiority required in the Area Of Operations (AO) necessary for successful operations. (FMFM5-60)

Determine Engagement Criteria/ROE: A1.5.2 Activities related to determining targets, conditions for attack, asset assignment for target surveillance, target acquisition, deconfliction, SEAD, and attack methods. Rules Of Engagement (ROE) are activities related to the coordinating the circumstances and limitations under which forces will initiate and/or continue combat engagement with other forces encountered. ROE allows the commander to exercise control over aviation units and aircraft by prescribing the exact conditions under which they may engage a target. The ROE tells aviation units what they can attack, where they can attack, and when they can attack. ROE will contain at a minimum: The right to self defense, target identification criteria, and weapons control statuses. (FMFM 5-60)

Determine Possible Air Control Architecture(s): A1.4.1.4 Activity related to determining possible air control Facility locations to provide positive control and those procedural control measures required to ensure continuity of operations under adverse environmental conditions, or the lack of positive control facilities.

Determine Possible Air Control Facility Location(s): A1.4.1.4.1 The command and control system is the means through which the commander controls and coordinates the variety of AAW systems involved in the detection, interception, and destruction of hostile targets. The efficient integration and coordination of the surveillance and destructive means is the key to making the system effective. Further, the command and control system should provide the means to maintain positive control over friendly air support operations in an antiaircraft missile environment in order to prevent mutual interference in the accomplishment of missions. (FMFM 5-5) Determining control systems involves selection, positioning, and the assignment of responsibilities. For a discussion of selection and positioning of control systems, see NWP 32. Responsibilities for the control of air defense are determined and assigned during planning. These assignments are in consonance with the missions and functions of the agencies. They establish priorities, communication and relationships, and tasks as conditioned by the locations and capabilities of the units involved. Generally, air defense control is not decentralized below the level of the TAOC. In addition to the assignment of general control responsibilities, special provisions and measures are provided for the following:

(1) Coverage limitations of surveillance equipment and weapons may require positioning of air defense systems outside the vital area. This dispersion requires special control provisions.

(2) Decentralization of functions is anticipated and planned for agencies which might become saturated in their target handling capabilities.

(3) Decentralization of functions is planned for the possibility of communication system failures. The circumstances for unilateral assumption of decentralized air defense control authority must be clearly defined. As such a failure may be progressive and/or widespread, each remaining agency must have compensatory activities assigned, particularly weapons control. Plans for control system degradation include preassigned aircraft electronic identification codes and the establishment of air corridors, control reporting points, restricted areas, and other special aircraft flight procedures to aid in friendly identification. All control agencies are furnished the locations of friendly aircraft orbit and control points to assure their awareness of friendly aircraft activity, thus providing aircraft a degree of safety in the event of ground system failures. Units required to form the control component are determined from an estimate of the quantities of AAW weapons which will be required for simultaneous employment, plus the size and nature of the area and the scope of operations. (FMFM 5-5)

Determine Possible Air Defense Control Measures: A1.4.1.4.4 Activities related to the establishment of measures in air defense that maximize the effectiveness of air defense operations while minimizing its interference with other operations. Air defense control measures must complement established fire support coordination and airspace control measures. Air defense control measures include Air defense operations areas, air defense action areas, air defense identification zones, air defense areas, regions, and sectors. (FMFM 5-60)

1. Air Defense Area: Activity related to the implementation of specifically defined airspace for which air defense will be planned and provided. The Joint Force Commander (JFC) may assign an Area Air Defense Commander (AADC) to coordinate and integrate air defense operations in the air defense area. (FMFM 5-60)

2. Air Defense: Region Activities related to implementation of the geographic subdivision of the air defense area. The CATF will normally be assigned an air defense region, with the Antiair Warfare Commander (AAWC) assuming responsibility for all air defense operations within that region. Regional air defense commanders (RADCs) can also be assigned to other air defense regions. (FMFM 5-60)

3. Air Defense Sector: Activities related to the implementation of the geographical subdivision of an air defense region. The CATF or the JFC will normally assign an air defense sector to the MAGTF. The MAGTF commander will assume control of the sector(s) which best supports MAGTF Operations. The MAGTF's air defense sector is under the control of the landing force sector Antiair Warfare Commander (LFSAAWC). The LFSAAWC operates out of the SAAWC operations Facility which is collocated or integrated in the TAOC, once ashore and operational. (FMFM 5-60)

a. Destruction Area: Activities related to determining that portion of the air defense sector where planning and execution for destruction or defeat of the enemy airborne threat occurs. The size of the destruction area will depend on the situation. The vital area falls within the destruction area. The air intercept, missile intercept, and antiaircraft gun zones make up the destruction area. The Marine Corps does not use the antiaircraft gun zones. (FMFM 5-60)

b. Designate Vital Area: Activities related to the determination or defense of the area(s) designated to be defended by air defense units. It contains facilities, units, and installations necessary for the MAGTF to accomplish its mission. The outward boundary or edge is always the reference point in application of the destruction-in-depth principles. More than one vital area may exist, depending on the scope of the amphibious or expeditionary operation. Vital areas can include airfields, command and control systems, combat support units, ground combat element (GCE) unit, and MAGTF command element. The MAGTF commander will define the vital areas through his establishment of air defense priorities. The vital area falls within the destruction area. (FMFM 5-60)

(1) Weapons Engagement Zones: Activities related to the establishment of airspace of defined dimensions within which the responsibility for engagement normally rests with a particular weapons system. These zones are generally identified as Low Altitude Missile Engagement Zones (LOMEZ), Fighter Engagement Zones (FEZ), Short Range Air Defense Engagement Zones (SHORADEZ), Crossover Zones, and Joint Engagement Zones. (FMFM 5-60)

(a) Air Intercept Zone: Activities related to recommendation or activation of the defined planned area where interceptor aircraft will destroy or defeat the enemy airborne threat. Various Fighter Engagement Zones further defines the interceptor responsibilities within the AIZ.

(i) **FEZ**: Activities related to the assignment of airspace of defined dimensions within which the responsibility for engagement rests with fighter aircraft. Each FEZ may have one or several CAP aircraft assigned to patrol it.

(ii) **Combat Air Patrols**: Activities related to the aircraft patrol over an objective area, over the force protected , over the critical area of the combat zone, or over an air defense area., for the purpose of intercepting and destroying hostile aircraft before they reach their target. (FMFM 5-60) If the CAP is within the air defense area, it is an air defense function.

(b) Missile Intercept Zone(s): Activities related to the recommendation or implementation of the area where surface-to-air weapons (missiles) will have primary responsibility for destroying the enemy airborne threat. Various MEZes fall within the MIZ. (FMFM 5-60)

(i) **LOMEZ**: Activities related to the assignment of airspace established for the control of low-to-medium altitude surface-to-air missile (HAWK) engagements. A low altitude missile engagement zone will limit the volume of airspace within which these weapons may conduct engagements without specific direction of the AADC. Subject to weapons capabilities, the LOMEZ will normally extend beyond the forward edge of the battle area.

(ii) **SHORADEZ**: Activities related to the assignment of airspace of defined dimensions within which the responsibility for engagement rests with the short range air defense weapons (Stinger, guns). The SHORADEZ may fall within a low altitude engagement zone or under a high altitude engagement zone. Some areas may be solely defended by SHORED assets. Because centralized control over the SHORED weapons may not be possible, these areas must be clearly defined and disseminated so friendly aircraft can avoid them.

(c) Joint Engagement Zone: Activities related to the assignment of airspace of defined dimensions within which multiple air defense weapons systems (SAW's and friendly fighters) of one or more services are simultaneously employed and operated. The JEZ is an option depending on the capability to have positive hostile identification (PHID) of missiles and fighters in the same airspace. (FMFM 5-60)

(d) Base Defense Zone: Activities related to the air defense zone established around an air base and limited to the engagement envelope of the short range air defense weapons defending that base. The BDZ have specific entry/exit and IFF procedures established. (FMFM 5-60) One or several SHORADEZs will fall within the BDZ, but other SHORADEZs may also exist in other locations not related to the BDZ. The BDZ procedures will be coordinated with the Air Traffic Control procedures to ensure the safe and expeditious control of aircraft. The BDZ will also require coordination with the TAOC to assist in early warning. The ATC will also provide early warning to the assigned weapons system.

(e) Crossover Zone: Activities related to establishing of the zone or point defining the boundary where an airborne target changes from an air intercept target to a surface-to-air missile target. It separates the AIZ from the MIZ, or adjacent WEZs, Where more than one type of weapons system has the capability to engage an airborne threat. A weapons system making an engagement in this zone will normally be under the positive control of Air Command And Control. (FMFM 5-60) Positive control would normally be provided by the TAOC, EW/C, or Airborne Early Warning.

4. Ingress/Egress/Return-To-Force(RTF) Control Procedures: Activities related to the establishment of procedures which allow friendly aircraft to safely move in, out, and through the MAGTF's airspace . Control procedures must be thoroughly examined, especially for safe passage of friendly aircraft through restricted areas. The use of these

control procedures should maximize the safety of the defended area while minimizing the possibility of fratricide. These control procedures include the use of: Low level transit routes, corridors, control points, visual identification, electronic identification via NCTR, TACAN, IFF equipment, Altitude and airspeed restrictions, Lame Duck Procedures(when aircraft have no communications, no IFF, battle damage, etc.), and ACAs to name a few. (FMFM 5-60) The established procedures will be altered periodically to ensure that the enemy cannot replicate them.

5. **Air Defense Warning Conditions**: Activity related to the establishment of the degree probability of air attack. The particular probability of air attack affects specific actions that will be taken by the entire MAGTF, to include aircraft, MACCS agencies, SAW units, and ground units. These specific actions are normally established in operations orders, Standing Operating Procedures(SOPs), etc. Air Defense Warning Conditions will be passed by the senior air control agency to all elements of the MAGTF. Warning conditions may differ from one area to of the battlefield to another due to the tactical situation and level of the enemy's air threat. In those cases where it is desirable to set different warning conditions for different areas of the battlefield, the ACE commander will designate the reference or grid system to be used. During independent operations, the senior organizational commander assumes responsibility for setting the air defense warning conditions. The three air defense warning conditions are: Air Defense Warning Red - Attack by hostile aircraft and/or missiles is imminent or in progress. This means that hostile aircraft and/or missiles are within an air defense divisions/sector or are in the immediate vicinity of the air defense divisions/sector with a high probability of entering the division/sector. Air Defense Warning Yellow - Attack by hostile aircraft and/or missiles is probable. This means that the hostile aircraft and/or missiles are en route toward and air defense division/sector, that unknown aircraft and/or missiles suspected to be hostile are en route toward or are even within an air defense division/sector. Air Defense Warning White - Attack by hostile aircraft and/or missiles is improbable. (FMFM 5-60)

6. **Weapons Control Status**: Activity related to the defining of the restrictions on firing air defense weapons for a particular area and time period. The entire MAGTF must be aware of the weapons control status, to include MACCS agencies, SAW units, aircraft, and ground units. Subordinate operational commanders have the authority to impose a more restrictive weapons control status within their sectors/zones of action. These commander can also request a less restrictive weapons control status for their operating areas. Independent operational commanders may be delegated the authority to set weapons control status for their operating areas. Weapons control status may be varied to apply only to certain aircraft for specified time periods. For example, weapons free for all aircraft heading westbound, weapons tight for all other aircraft is not unusual. Weapons control status are defined as: Weapons Free - Weapons control status used to indicate that Air defense weapons systems may be fired at any target not positively identified as friendly. Weapons Free is the most desirable weapons control status for SAW units as it lessens restrictions on the units and maximizes the capabilities of the systems. Weapons Tight - Weapons control status used to

indicate that Air Defense weapons systems may be fired only at targets identified as hostile (in accordance with prevailing target ID criteria). Weapons Hold - Weapons control status used to indicate that Air Defense weapons systems may only be fired in self defense or in response to a formal order. In the event of lost communications, the air defense units will follow the weapons control status procedures detailed in the applicable operations order or SOP. (FMFM 5-60)

Determine Possible Airspace Control Measures: A1.4.1.4.3 Airspace control measures are procedural control measures designed to maximize the effectiveness of combat operations by promoting safe, efficient and flexible use of airspace. Airspace control measures are used to delineate or modify hostile criteria, delegate target identification authority, or serve as aids for fire control. The assignment of Amphibious Objective Area (AOA), airspace control sectors, and air control points directly relate to airspace control measures. (FMFM 5-60)

Determine Possible Command Facility Location(s): A1.4.1.5 Activity related to determining the location of the TACC which is the command facility for the ACE and the alternate command facilities. The governing factors in site selection are accessibility, area size, shape and physical contour. The selected site must provide for ingress and egress of TACC shelters by one of the feasible modes of transportation. The shelters are designed to operate at a maximum angle of 20 degrees. (MACCS Reference Guide) Consideration must also be given to the communications limitations and the best location to receive and maintain the tactical picture and influence the battle.

Determine Possible Fire Support Coordination Measures: A1.4.1.4.2 Fire support coordination measures allow a commander to open up areas for rapid engagement of targets or to restrict the control of fires. Since Marine aviation is a source of firepower, it can be affected by fire support coordination measures. The Airspace Coordination Area (ACA) is a fire support coordination measure that is a three-dimensional block of airspace in which friendly aircraft are reasonably safe from friendly surface fires. The ACA acts as a safety measure for aircraft while allowing other supporting arms to continue fires. (FMFM 5-60) The ACA may be utilized during TM Attack Operations.

Determine Possible Sensor Location(s): A1.4.13 An effective AAW system requires the capabilities to detect, locate, and identify hostile targets on the ground and in the air. This surveillance system must have communications for transmitting acquired information to a control agency. The method of surveillance may be electronic, photo, infrared radiation, or visual techniques. Operational characteristics of AAW surveillance equipment should provide long-range detection and identification at all altitudes for early warning. The surveillance system must also provide accurate range, bearing, and altitude discrimination for weapons control and the ability to observe and identify ground targets. The landing force surveillance system must also be compact and lightweight and possess the mobility that will ensure ease of handling for amphibious operations. (FMFM 5-5) Detection for attack operations requires identification of prelaunch and postlaunch signatures and the accurate

location of the launch system. To support attack operations in all environments, diminish the effects of enemy countermeasures, and capitalize on distinctive signatures of TM equipment, and operations, the surveillance capability will be multispectral, and integrate national-level intelligence and other externally furnished information with theater-level significance. Detection will involve segmentation of the battlespace of the battlefield to accommodate a systematic search of specified areas identified in the IPB. (Joint Publication 3-01.5) Visual observers will also be included into the sensor category. The ACE will be responsible for providing protection against TM s in the terminal phase (determined by the maximum range and altitude at which a TM can be targeted by the HAWK missile system). Since it should be expected that an enemy attack may integrate aircraft and missiles, TM active air defense operations will be integrated into the ACE air defense system. (Joint Publication 3-01.5) The sensor selection and emplacement will take into account these dual requirements.

Determine Possible Weapon Location(s): A1.4.1.2 The determination of the required number and disposition of weapons components, both SAM elements and aircraft, is based on the minimum safe intercept point for each type of threat, enemy delivery technique, attack altitude, attack speed, ordnance, and anticipated rate of attack. Another determinant of weapons selection is the time lapse between target detection and actual interception. This time lapse is minimized by selecting optimum weapons systems and positions. This determination of aircraft and SAM elements requires consideration of the following factors;

1. **Aircraft Requirements**

   a. Depth of the antiair warfare area which the landing force may be assigned.

   b. Operating characteristics and firepower of the aircraft.

   c. Expected duration of the operation.

   d. The total destruction expectancy which the landing force AAW system can achieve during the different phases of the amphibious operation.

   e. The expected attrition rate for landing force fighter aircraft.

   f. Fighter aircraft provided by commands external to the landing force.

   g. Other factors as may be imposed due to the nature of a particular amphibious operation.

2. **Surface-to-Air Missile Requirements**

a. The effects which weather, terrain, and hydrographic conditions may have on deployment of antiaircraft missile units.

b. Operations ashore extending beyond the support of naval antiaircraft missile elements or when operations continue after naval forces are withdrawn.

c. The number, size, and distance between AAW vital areas.

d. The type and duration of naval antiaircraft support available.

e. The number and type of aircraft units available.

f. Helicopter availability and AAW weapons systems transportability. (FMFM 5-5)

Determine Situation and Courses of Action: A4.2 Activities related to determining the current situation and possible course of action. (AFSC Pub 1)

Determine Size, Profile, Launch & Probable Impact Point: A3.1.3.4 Once all of the tracks are associated, the size of the raids, profile information, launch point can be determined. The impact point will be calculated in the AN/TPS-59 radar for TM tracks that it produces, other sensors will be responsible for placing the information on the JTIDS link.

Determine Surveillance Area Readjustment: A3.1.1.1 The surveillance area is the area in which air search, detection, and tracking are accomplished. It must extend beyond the destruction area to allow enough warning that reaction times will permit engagement as the target reaches the destruction area. This surveillance area is not coincidental with the destruction area as it is not limited by interceptor positive control restrictions. Further, the destruction area is oriented totally toward the assigned air defense sector of responsibility, while the surveillance area might extend into another air defense sector. Lag time is the sum of all times required to collect, evaluate, and commit a weapons system to a detected air defense target. The surveillance area is expanded to absorb this lag time by converting the most logically anticipated target speed into distance. One particular qualification applies to this surveillance area for low-altitude detection. When surface radar is employed as the principal method of detecting low-altitude targets over land, extended range is better attained by locating radars on high elevations and supplementing coverage with gap filler radars displaced inland. Special visual zones in specific avenues of approach may be used beyond the vital area or surrounding installations to further supplement this coverage. (FMFM 5-5)

Determine Surveillance System Re-Positioning Requirements: A3.1.1.2 Activity related to determining if the current surveillance network is providing an adequate picture of the battlespace, if not and a better picture is required, then a repositioning of assets may be necessary. Surveillance positions must be considered as an integral portion of the ground scheme of maneuver to ensure that the appropriate locations are taken to provide the most effective surveillance network possible.

Determine Threat Composition: A3.1.5 Activity related to fusing all available track information to associate the tracks and determine the probability that the tracks are acting as a raid or are associated. This is a manual process that is aided by TADIL information and displays.

Determine Time-to-Intercept Estimate: A1.3.1 Activity related to developing time and space relationships and systems capabilities to provide an estimate of reaction time and ability to maintain operational momentum. (FMFM 3, Section 2005) It includes determining the effects of topography, masking, mobility, trafficability, vegetation, foliage, and environmental effects on the proposed battlespace on weapons and command and control.

Develop C2 Architecture Options: A1.4.1 Activity related to integrating TMD systems into existing C2 architecture. The Command and control structure must provide command authorities at all levels with timely and accurate data to plan, monitor, direct, control, and report TMD operations. (Joint Publication 3-01.5) The MACCS gives the ACE the ability to exercise centralized command and coordination and decentralized control of MAGTF air assets and operations. It also affords him the means to coordinate air operations with other services. (FMFM 5-60) The MACCS also provides the command and control structure required to integrate TMD into the existing AAW architecture.

Develop C3 Architecture: A1.4 Activities related to determining the C3 architecture. Once the battlespace area and the time factors are determined, the commander facilitates command and control by organizing his command and control organization and C2 support system into a framework that orders the battle, provides control measures, and integrate the MAGTF's efforts in order to achieve the desired effect on the enemy. (FMFM 3, Section 2005)

Develop Communications Architecture Options: A1.4.2 Satellite communications is essential to support the vast distances and required operational interfaces with reliable networks to support both the vertical and horizontal flow of information. These and many other highly technical systems and resources are essential to support the efficient flow and processing of information. However, the demand for information always exceeds the available support resources. It is therefore crucial to focus information requirements to determine the need and priority for C2 support systems.

Develop Plans: A1.6 Activities related to the creation of plans necessary to accomplish AAW operations.

Display and Disseminate: A.3.3 Maneuver warfare demands that the C2 support system create a common situational awareness throughout the battlespace by rapidly sharing information among the commander, his staff, key decision makers, and supporting forces. The C2 support system controls the processing and flow of information and integrates all-source, multimedia, and multiformat information into an accurate, complete summary. Decision makers then access the information required to maintain situational awareness. The commander's ability to access, on demand, only the information critical to the area of operation allows him to avoid information overload and increases his ability to react. (FMFM 3, Section 4001) The landing force AAW system is required to handle a large number of air contacts (friendly and enemy) through a high speed data processing system. This requirement increases in importance whenever friendly forces on the offensive require large numbers of air support aircraft in the objective area. An enlarging AAW area increases the number of air contacts that will be detected. The enemy possesses the capability for launching mass air attacks. (FMFM 5-5) In identifying the items of air defense summary display, only the TAOC and TACC are discussed. All other associated air defense agencies maintain similar displays.

1. **TAOC**: The following information is made available to the TAOC on a real time basis and is necessary to achieve threat evaluation and weapon assignment: The location, composition, status, and alert condition of all friendly air defense weapon. Particular items required for CAP aircraft are: type of aircraft, number of aircraft, control frequency, armament; and Fuel state. The location, identification, and controlling agency of all friendly aircraft within the surveillance envelope. Major equipment status of subordinate and adjacent air defense units. The location, composition, speed, altitude, and course of all unknown/assumed hostile/hostile aircraft. The status of controlled airborne intercepts to include aircrew assumption of intercept, attack mode, weapons release, and completion or noncompletion of the intercept. ECM/ECCM conditions.

2. **TACC**: For air defense purposes, the TACC requires the following information: The location, composition, speed, altitude, and course of all unknown/assumed hostile/hostile aircraft from all subordinate and adjacent agencies. Major equipment status of subordinate and adjacent air defense units. Commitment status of air defense weapons. ECM/ECCM conditions. Readiness conditions and availability of unassigned weapons. (FMFM 5-5) Dissemination is the distribution of processed information, with the addition of human insight, vision , and direction, to its appropriate user. The commander determines what information is disseminated to everyone, to designated units or elements (higher, lower , adjacent) or to key individuals. The commander also establishes the priority of information. If possible, dissemination is predetermined and automated to avoid delaying receipt of critical information. (FMFM 3, section 4003) Dissemination includes the dissemination of

launch warning information to all components, allies, and host nation civil authorities for population warning as appropriate. (Joint Publication 3-01.5)

Employ/ Maneuver Forces: A2 AAW Weapons means are employed and/or located in such a manner as to ensure continuity of engagement and provide for mutual support. In this way, the landing force increases the probability of preventing the penetration of the AAW vital area by hostile aircraft or missiles. Proper employment and/or location ensures that each target is within range of several AAW elements. This integrated and overlapping pattern of mutual support and continuity of engagement minimizes any reduction in effectiveness of the AAW system resulting from loss of one or more AAW elements. (FMFM 5-5) During the conduct of air defense operations ashore, surveillance facilities are established, weapons are placed in position, and offensive AAW strikes are conducted to reduce the enemy threat to a manageable level. Air control management requires supervision and coordination of all tactical air support operations to include the integration of aircraft from a variety of sources and the establishment of air defense sectors. Detailed local planning examines contingencies related to both enemy air successes and system failures within the MACCS. Due to the significance of the threat, all control agency personnel must be familiar with the immediate actions required to offset foreseeable degradation. In order to obtain this familiarity, standardization and a thorough knowledge of participant responsibilities and relationships are necessary. The primary determinant in establishing the air defense system's standards for surveillance and destruction is the enemy air capability. This capability is ascertained by an analysis of the most successful counter weapons available and the distribution of friendly forces/installations which require air defense protection. Following the identification of these factors, the composition and deployment of specific air defense elements are planned. In order to obtain the optimum degree of air defense protection with available forces, capabilities are examined, and operational requirements are determined. (FMFM 5-5) Emplacement/Maneuvering of Hawk unit. The performance characteristics of enemy aircraft represent a technical challenge which the Hawk system has been designed to defeat. Enemy force capabilities, on the other hand, are a tactical challenge which impacts upon the number and type of Hawk units required and the manner in which they are deployed. Enemy ground force as well as air force capabilities must be considered, since Hawk units are vulnerable to ground attack while in position and to ambush and mining tactics while on the move. The assessment of combined enemy capabilities raises deployment considerations which may conflict. For example, an air capability which is not extensive may permit the concentration of Hawk units at the most vital of assets and the use of position areas which inherently provide excellent mutual fire support and local security. Conversely, an extensive enemy air capability may force consideration of the extensive dispersion of Hawk units to cover all forces and assets, which in turn will force consideration of the resultant reduction in mutual fire support and vulnerability of remote units of both air and ground attack. All of the considerations and conflicts imposed by enemy force capabilities must be weighed and resolved at battalion or higher levels. (FMFM 5-5)

Engage Aircraft or UAV: A5.2.1 Within a single sector of air defense responsibility, the engagement sequence depends upon the position at which the target is identified. Under ideal circumstances, this position is at the limit of the surveillance area, well beyond the CAP stations. Time and position allowing, the first engagement will be made by interceptor aircraft according to the desired process: i.e., single aircraft attack-reattack or single front attack by one or more interceptors. Should the success of the intercept be questionable, as the target approaches the crossover zone, missile batteries will be directed to acquire and lock-on. Once the target reaches the crossover point, the decision is made whether to allow the interceptor to continue his attack or to assign the target to the SAW system. If the interceptor is in position to fire and the sector antiair warfare coordinator concurs, the SAW units will be given a CEASE FIRE command to allow completion of the interceptor attack. If not, the interceptor will be directed to break away and the missiles will engage the target. (FMFM 5-5)

Engage Cruise or Air-to-Surface Missile: A5.2.2.2 Cruise missiles create a somewhat different challenge from TM s, Aircraft or UAVs. They can be air, land, or sea launched and normally fly to their target at low altitude, thus creating an acquisition problem. Often, they follow an unpredictable trajectory that makes it difficult to determine their point of launch or to predict their exact impact point. The mobility of the cruise missile launch platforms, the small launch signature of the missiles, and their reduced radar cross section also complicate TMD operations. Stealth technologies can be incorporated into cruise missiles, making them an even more challenging target. A robust combination of friendly active air defense and attack operations is required to defeat the Cruise missile threat. (Joint Publication 3-01.5) It is for the above reasons that engagement of cruise missiles is broken out.

Engage Missile Launch Platform: A5.3.2.2 Activity related to conducting an engagement of a TEL or Missile platform.

Engage TBM: A5.2.2.1 A TBM will be engaged at the farthest possible point from the protected vital area. The most desirable situation is for a TBM to be engaged by a Boost phase of mid-course TMD asset prior to its entering the HAWK engagement area. The HAWK missile system can engage only those targets that will fall within its limited engagement zone and will use a ILM missile for the engagement.

Engage Theater Missile: A5.2.2 Activity related to engaging a TM that is already in flight. The HAWK system coupled with TAOC radar in the TBM or Combined mode of operation provides the terminal phase engagement capability. Other theater missiles will be engaged in the same manner as a ABT.

Engage With ACE Assets: A5.3.2 Activity related to tasking an ACE asset to conduct an attack on the TEL or Missile Platform.

Establish EMCON Plan: A1.4.2.4.3 Activity related to establishing the selective and controlled use of the electromagnetic, acoustic, or other emitters to optimize command and control capabilities while minimizing, for operations security, detection by enemy sensors; to minimize mutual interference among friendly systems; and/or to execute a military deception plan. (FMFM 5-60)

Establish LAN/WAN Options: A1.4.2.2.3 Activity related to establishing local area networks that are used mainly for administrative traffic.

Establish Landline Options: A1.4.2.1.3 Activity related to establishing the landline requirements to support operations. Landlines are the preferred method of communication in most cases.

Establish Launch Warning Options: A1.4.2.1.5 Developing and executing plans for dissemination of launch warning information to all components, allies, and host nation civil authorities for population warning, as appropriate. (Joint Publication 3-01.5)

Establish & Maintain Tactical Picture: A3 Activity related to providing a display of the near real-time status of the battlespace. It includes all friendly and enemy air vehicles.

Establish Management Procedures: A1.4.2.4 Activity related to managing the communications architecture to provide for effective, efficient and timely dissemination of information.

Establish Point-to-Point Data Link Options: A1.4.2.2.2 Activity related to establishing the architectures for the point-to-point links between: AN/TPS 59 radar and the TAOC(for ABT until 1998 then both) AN/TPS 59 radar and the ADCP (for TMD until 1998) ADCP and the HAWK BCP (IBDL) ADCP and the HAWK Launcher (GBDL) Point-to-point data links activity also include the usage of tactical computers linked via modems for passage of information such as the ATO.

Establish Possible Data Communications Architectures: A1.4.2.2 Activity related to establishing all data communications architectures.

Establish Possible Voice Architectures: A1.4.2.1 Activity related to determining the extensive communications network required for the volume and speed of traffic involved with air operations and their effective command and control. It will provide for interagency/service, intra-agency, and air-to-ground/ground-to-air communications. (FMFM 5-60) It also includes the net required to communicate a launch warning to the host nation civil authorities, if required.

Establish Radio Communications Options: A1.4.2.1.4 Activity related to establishing which portion of the voice architecture will be by tactical radio.

Establish SATCOM Options: A1.4.2.1.2 Activity to establish the SATCOM requirements. This is especially important for TMD which requires extensive intelligence, surveillance and reconnaissance information from theater or national sources.

Establish TADIL Interface Options: A1.4.2.2.1 Activity related to establishing a TADIL interface that is flexible enough to adapt to the tactical scenario as it unfolds and robust enough to continuously provide the ACE with an accurate depiction of the status of the battlespace.

Establish Technical Control Procedures: A1.4.2.4.4 Activity related to the establishment of procedures to maintain the voice architecture at peak operating capacity.

Establish Voice Interface Requirements: A1.4.2.1.1 Activity to establish the voice interface requirements to conduct AAW operations. The next step is to determine what assets will be used to provide the necessary connectivity.

Examine Current Mission Objectives: A4.1 Activities related to the examination of the assigned or deduced task and its purpose. Determination of any immediate tasks, prescribed or deduced, necessary to the accomplishment of the mission. (AFSC Pub 1)

Examine MAGTF Mission Objectives: A1.2.2 Air Defense considerations affect the MAGTF commander's course of action. The MAGTF commander must establish his air defense priorities. The enemy air and missile threat and the type of AAW requested determine the degree of destruction or reduction necessary. If existing air defense assets pose prohibitive interference to MAGTF operations, the MAGTF Commander assigns high target priority to their elimination or neutralization. If assigning terrain objectives for air defense purposes, the MAGTF Commander must give priority to the early establishment of air defense facilities ashore. (FMFM 5-60) Since Marine aviation is a major, combined arms asset of the MAGTF, the ACE objectives are derived from and in conjunction with the MAGTF commander's objectives. Understanding the MAGTF's objectives allows the ACE and subordinate units to estimate the AAW role that will be required to support the MAGTF Commander's scheme of maneuver.

Examine Political, Legal & Religious Requirements: A1.2.1 TMs may be as much a political or religious weapon as a military weapon. In many cases, their political impact may outweigh their military significance. (Joint Pub 3-01.5) This activity relates the process of identifying the political and legal limitations or considerations which have been place on the conduct of the mission. For TMD, there may be a requirement to protect political targets from attack by theater missiles, this requires a clear understanding of legal and political issues especially relating to host nation sovereignty issues.

Execute: A5 Activity related to transforming the commander's desires into actions. Active AAW operations are those actions taken to destroy, or reduce to an acceptable level, the

enemy air threat. Included are those measures taken to destroy this threat prior to and after launching. Upon entry into the objective area, MAGTF AAW operations consist mainly of offensive strikes to destroy hostile aircraft and missiles and to neutralize airfields, radar installations, missile sites, and logistic support facilities. As the capability of the enemy to reconstitute his air resources varies, neutralization of the enemy air potential continues, employing interceptor sweeps, attack bombing, and aggressive air search and surveillance. These operations are intended to supplement the preliminary offensive AAW activity previously conducted by carrier attack forces or area forces. Air defense measures to protect the MAGTF from residual enemy air constitute another category of active AAW. (FMFM 5-5) Destruction in depth, mutual support, and centralized coordination and decentralized control are three principles of antiair warfare which have evolved from years of experience in opposing an air threat. The application of these principles is necessary to achieve and preserve air superiority. Destruction-in-depth is considered the most important principle of AAW. The main effort is to destroy the enemy air threat at its source. In this respect, sector boundaries are assigned within the area of responsibility. The principle of mutual support involves the simultaneous engagement of a target by multiple elements of the same type weapon. The principle of centralized coordination and decentralized control offers the best means of achieving economy of forces while minimizing the reaction time and vulnerability to losses. (FMFM5-5)

Initiate Mission: A5.3.2.2.1 Activity related to initiating the OAAW (Attack ops) mission. For Artillery it is a call for fire. For an OAAW mission, it is a JTAR request or a "Nine-Line Brief" for airborne aircraft. It provides the initial information to commence the mission, but may not contain complete target identification.

Obtain Engagement Quality Track Information: A5.2.2.1.3 The HAWK system requires accurate targeting information that is currently available only through the AN/TPS-59 radar. This targeting information allows enough resolution for the HPI to commence tracking with its pencil beam radar and thus allow for the TBM to be engaged.

Obtain Launch/Impact Point: A5.2.2.1.1 Activity related to determination of the Launch and impact point of a TBM. The AN/TPS-59 radar will have the capability of determining both launch and impact point to allow for the earliest possible determination of the ability of the HAWK to intercept or if must be taken to further reduce the extent of damage. Other sensor information may only provide a launch point and the type of TBM this, would require manual determination of the impact point and will all but eliminate the HAWK's ability to intercept.

Obtain TEL/Platform Location: A5.3.2.2.2 Updates Depending on the capabilities of the sensor and surveillance systems, and the source and quality of intelligence, cuing of additional systems may be necessary to provide more refined enemy missile launch point data to ensure accurate targeting. National or theater sensor and surveillance assets may be able to detect, footprint, or search areas that will then require more refined RSTA activities

by theater and tactical assets. Friendly aerial reconnaissance, ground surveillance systems, and other intelligence asserts requiring cueing are focused rapidly to achieve the necessary accuracy for IPB targeting objectives. (Joint Pub 3-01.5) Initial indications are that the target resolution needs to be, for aircraft, 1000 SQ M in a desert climate, 200 SQ M in a mountainous climate and 100 SQ M in all climates for artillery. The updated information needs to arrive at the weapons platform 90-180 seconds after mission initialization. (Meeting MAWT-1) Point weapons such as general purpose bombs, or PGMs will require target acquisition by the delivery platform. Area weapons such as ATACMs, cluster bomb units, or scatterable mines, may only need a geographic aim point aircraft diverted from other missions will require target location, a clear target description, the appropriate type of imagery (SAR, IR, or EO) the weapon system will need to detect the TM, target altitude, best attack axis, and controlling agency (if applicable). The degree of detail will vary dependent upon the type of munitions available and the on-board sensor system.

Perform Threat ID & Assessment & Determine Relative Combat Power: A1.1 Perform Threat ID/Assessment & Determine Relative Combat Power Threat assessment should permeate the entire planning process from the time of the mission receipt to the time of mission accomplishment. As the threat changes, the employment plan will must change accordingly. The threat assessment will include: Air Order Of Battle, Ground Order Of Battle, Electronic Warfare, Reconnaissance (Both ground and air) and terrorists or unconventional threat. Throughout the assessment of the threat, the enemy's capabilities must be examined with respect to the friendly situation ACE and MAGTF capabilities, limitations, and intentions. (MACCS Tactical Planning Guide) The Intelligence Preparation of the Battlefield serves as the basis for the threat analysis and assists in determining the follow areas:

Determine Air Order Of Battle Process related to creation of an assessment of threat Air capabilities. It extends beyond the normal encyclopedic-type data on airframe capabilities and limitations and includes enemy's ordnance capabilities, extent of training and morale, their likely tactics, and their intended likely targets. (MACCS Tactical Planning Guide)

Determine Ground Order Of Battle Activities related to collecting information on the threat's surface to surface missile (SSM) threat. Specific areas to address when conducting the assessment of the threat's SSM capability include: location, range, accuracy, ability to rapidly displace and be ready to fire once again. Particular attention is given to the threat's mechanized capability, as it will likely impact on the siting of agencies which conduct the control of aircraft and missiles. (MACCS Tactical Planning Guide) Determine EW Capabilities Activities related to determining the threat Electronic Warfare Support (ES) and Electronic Attack (EA) capabilities. (MACCS Tactical Planning Guide)

Determine Reconnaissance Capabilities Determination of the threat's Airborne and Ground reconnaissance capability. (MACCS Tactical Planning Guide)

Determine Terrorist/Unconventional Activities related to the determination of potential terrorist or unconventional operations capability. A terrorist with a well-aimed sniper round or a well placed satchel charge can just as easily disrupt the MAGTF's ability to effect the control of aircraft and missiles as can an aircraft with ordinance. (MACCS Tactical Planning Guide)

Plan for Execution: A1.5 Activities related to conducting coordination with higher, adjacent and subordinate units, translating the ACE Commander's intent and priorities into projected AAW missions and coordinating support for these missions.

Provide Command and Control: A5.1 The basic principle involved in the command and control afforded by the AAW system is that the results of coordinated effort are greater by many times than any possible results of the random separate efforts of individual units. This increased effectiveness is derived from the manner in which the functioning and effect of each component is complemented by the other components. This requires a centralized control for coordination, overall authority, and responsibility; and decentralized control for short reaction time. The delegation of authority to control any of the subsystems is governed by the capabilities of the system and subsystems as related to the situation. In modern AAW, the delegation of authority to subordinate control agencies is required to reduce force reaction time. The MAGTF commander, through his ACE and the agencies of the Marine air command control system, commands, controls, and coordinates Marine tactical air operations. The MACCS, while primarily responsive to the MAGTF commander, must also be compatible with and supportive of other like systems within the joint force. The TACC/TADC is the primary point of contact for operational aviation coordination with JTF and forces external to the MAGTF, although subordinate agencies may interface directly to exchange information. When engaged in joint operations, aircraft of more than one service may be required to traverse and/or conduct operations in portions of the same airspace, thereby necessitating procedures to minimize mutual interference and to maximize operational effectiveness and safety. Under such conditions, it is essential that all aircraft operate under an integrated airspace control system. Any airspace control system must, however, be responsive to the ground commander's need for artillery and/or naval gunfire support, as well as providing for air defense and ensuring flight safety. The joint force commander establishes general airspace control procedures and responsibilities to achieve the maximum safety and operational effectiveness. The joint coordinating authority for air is additionally responsible for the coordination of airspace control. The purpose of any coordination must be to maximize effectiveness and efficiency. In this case, however, the effectiveness of the coordinated ground, surface, and air effort is the prime consideration, not merely to increase efficiency. Within the MAGTF sector of responsibility, the TAOC is the major en route air traffic control facility, and the Marine air traffic control unit provides terminal air traffic control. Provide Airspace Control Activities related to providing for the coordination, integration, and regulation of the use of a defined airspace. It also provides for the identification of airspace users. Airspace control is the authority to direct the maneuver of aircraft so the best use is made of the airspace. Airspace control authority is inherent to

the commander whose unit is responsible particular blocks of airspace, types of missions, or types of aircraft. It does not include measures to approve, disapprove, deny, or delay air operations. (FMFM 5-60) Provide Positive Control Activities related to the method of providing positive identification, tracking, and direction of aircraft within an assigned airspace, conducted with electronic means by an agency having the authority and responsibility therein. Positive control relies on real-time tracking, direction, direction, and identification of aircraft by agencies equipped with capabilities such as radar, identification friend or foe (IFF), computers, digital data links, and communications equipment. Positive control can be equated to electronic control. Units must have backup procedures in the event of failure of part or all of their positive control systems. Two conditions must exist for a commander to exercise positive control of aircraft and missiles: (1) Means to identify and locate airspace users, and (2) Continuous communications must be maintained with airspace users. (FMFM 5-60) Provide Procedural Control Activity related to establishing non-electronic methods to provide airspace control. Usually through the use of control points, and airspace restrictions and special use airspace. These procedures allow for flexibility when air operations are in areas with little or no communications, when air operations are in areas where no electronic surveillance assets are employed or in extreme environmental conditions such as Jamming or atmospheric interference. (FMFM5-60) Provide Continuity Of Engagement & Mutual Support AAW weapons means are employed and/or located in such a manner as to ensure continuity of engagement and provide for mutual support. In this way, the landing force increases the probability of preventing the penetration of the AAW vital area by hostile aircraft or missiles. Proper employment and/or location ensures that each target is within range of several AAW elements. This integrated and overlapping pattern of mutual support and continuity of engagement minimizes any reduction in effectiveness of the AAW system resulting from loss of one or more AAW elements. (FMFM5-5)

Provide Track Monitoring: A3.2 Once initial radar detection has been made, the air defense control agency requires a means of maintaining the changing position of the radar contact. It is additionally necessary to keep abreast of the movements and intentions of friendly aircraft operating within the objective area. For this purpose, surveillance operators, traffic controllers, and weapons controllers are stationed in the TAOC. Once traffic is detected and identified as friendly, they are passed to a TAOC traffic controller whose function is to provide flight following navigational assistance, and altitude separation from other air traffic. Traffic controllers are normally assigned geographic subsectors in which they maintain accurate and timely situation data on all friendly aircraft. Their tasks include control of aircraft reporting for flight following. These personnel assist the surveillance effort by sustaining timely information on targets already processed for identification. Weapons controllers are responsible to ensure current track status on interceptor aircraft under control. When CAP stations are not actively manned, weapons controllers may function as additional traffic controllers. (FMFM 5-5)

Receive Cuing, GCI or Detect Target Locally: A5.2.1.1 If the target is detected by a sensor other than that of the weapons platform, cuing will be provided in the form of a point out (i.e. 240- at 10,000 feet from your position) over a voice net or a symbol and command will be initiated via the TADIL. Aircraft could be provided with one of several forms of Ground Controlled Intercepts to the target. In the case of low-flying aircraft, the weapons platforms may be the first to detect and therefore will have total situation awareness on the target.

Reload Missile: A5.2.2.1.6 The reload capability required to sustain a high rate of fire is provided by the loader. Although in normal operation the loader handles missiles three at a time, it can load or unload from one to three missiles. The loader is a tracked vehicle with a superstructure of movable missile supports which are controlled from the driver's compartment. During a loading operation, the loader indexes to the pallet or launcher for load support during missile transfer. If required, the loader may be converted to a crane by attaching a single fixture. (FMFM5-5)

Reload/ Reconstitute: A5.2.1.5 Activity related to reloading the HAWK missile launcher or providing air-to- air refueling to CAP aircraft with available weapons.

Request External Engagement: A5.3.3 Activity related to requesting assistance from the MAGTF, NEX, or JTF commander for weapons or capabilities that are not available within the ACE.

Resolve Shortfalls: A1.5.4 Activity related to resolving shortfalls by re-allocating MAGTF assets or requesting support from external sources.

Set Mode of Operation/Readiness State: A3.1.1.3 The setting or requesting the mode of operation for sensors includes sensors at all levels operational to strategic. A discussion of the specifics for the mode of operation is normally available technical or reference manuals. The mode of operation is important to the MAGTF because of the multiple mission capability of the AN/TPS-59. The selection of Air Breathing Target (ABT) mode or Theater Ballistic Missile (TBM) mode will affect the capabilities to conduct AAW. Appendix G provides a brief summary of capabilities. The TAOC establishes the sensor readiness sate based on the anticipated or existing air defense situation, ensuring the passage of information on friendly, unknown, and enemy aircraft to the DASC, the command post of the LAAD battery. These sensor readiness states could be: "2 minutes"; sensors can be operational within 2 minutes. "5 minutes"; sensors can be operational within 5 minutes. "15 minutes"; sensors can be operational within 15 minutes. "30 minutes"; sensors can be operational within 30 minutes. "1 hour"; sensors can be operational within 1 hour. "3 hours"; sensors can be operational within 3 hours. "Released"; sensors are released from surveillance commitment for a specified period of time. Although sophisticated radar systems require considerable maintenance for ideal performance, they are capable of operating at levels less than optimum. Those radars considered essential to achieve required detection probabilities

must be assigned a minimum acceptable level of degradation. Once this level is exceeded, for any reason, standby radars assume the surveillance activity, while also meeting performance standards. If primary radar assets permit sufficient overlap coverage, standby radar requirements may be reduced. However, overlap coverage is often degraded by adverse terrain characteristics and requires the utilization of secondary radars as a supplementary measure. When resources are limited, priorities are established for the employment of secondary radars. (FMFM 5-5)

Weight Air Control/Coordination Measures: A1.4.1.4.5 Activity related to weighting the combinations of air control, airspace control measures and air defense control measures. The intent is to arrive a combination that allows for the best integration of coordination, integration, regulation and identification. (FMFM5-60) Coordination. That degree of authority necessary to achieve effective, efficient, and flexible use of airspace without providing command authority. Integration. Considers the need to combine requirements for the use of airspace in the interest of achieving a common goal at the lowest possible level. Regulation. The requirement to supervise activities in the airspace to provide for flight safety and connotes the authority to ensure safe flight. Identification. Promotes timely engagement of enemy aircraft while reducing the potential of fratricide.

Weight C2 Options: A1.4.1.6 Activity related to weighting the command and control options to assist the commander in determining the framework that orders the battle, provides control measures, and integrates the ACE's efforts in order to achieve the desired effect on the enemy. The commander will determine the weighting to be assigned.

Weight C3 Architecture Options: A1.4.4 The combined weighted C2 and communications options are combined into a weighted matrix of options that are then provided to the ACE Commander for inclusion in the AAW plans and for final selection during the employment phase.

Weight Communications Options: A1.4.2.3 Activity related to weighting the communications options so that an optimum mix can ultimately be determined by the ACE Commander.

APPENDIX D. DEFINITIONS: INPUTS, OUTPUTS, CONTROLS, AND MECHANISMS

This appendix is provided as an aid to the reader. It is being prepared by Marlen Conklin, Naval Command Control and Ocean Surveillance Center (NCCOSC), RDT&E Division, Code 411.

AAW Reports

To be determined.

Airspace

The total airspace surrounding the proposed AO.

ACE

Aviation Combat Element- The ACE is task organized to conduct air operations. It consists of an ACE commander, aviation staff, and its own command and control support. The ACE has organic aviation command, combat support, and combat service support units. There is only one ACE in a MAGTF. If required, units of the ACE can be based at diverse locations to speed response. (FMFM 3 Section 3003)

ACE Agencies

All agencies belonging to the ACE.

ACE Assets

The ACE assets are organic ACE assets that are available to prosecute the AAW Mission. The major asset categories are broken out below.

ACE Assets (Aircraft)

This category includes all Aircraft available to the ACE. This includes the FA/18 as the primary radar capable CAP aircraft; AH1 and AV8 as visual CAP aircraft, and all other aircraft that either provide a strike capability for the OAAW mission or provide support to the strike mission. It also includes any support aircraft that transports or moves AAW ordnance or weapons platforms.

ACE Assets (Aircraft, UAV)

Unmanned aerial vehicles (UAV) - ballistic or semi-ballistic vehicles, cruise missiles, and artillery projectiles are not considered UAVs. (Joint Pub 1-02)

ACE Assets (Communication)

This category includes all Organic ACE communication assets. For a complete discussion of the assets, FMFM 3-30 and the appropriate technical manuals must be referenced.

ACE Asset (Comm - Radio Equip)

Ultra-high frequency (UHF) radio(s) and crypto (KY-57/58)

Very-high frequency (VHF) radio(s) and crypto (KY-57/58)

High frequency (HF) radio(s) and crypto (KY-75/advanced narrow band digital voice terminal [ANDVT])

The plotter receives information from TAOC operators and/or determines the current air situation from listening to various radio nets.

This air threat environment might preclude missions such as immediate CAS, as the requirement for effective radio communications and coordination may not be possible. (FMFRP 0-14)

Radio - speaker available to broadcast in SOF any VCAU net/line. A radio rack with four (objective of six) shelves will be provided. The rack will allow various radios to be operated within the SOF and will provide external access to enable radio/antenna cables remoted external to the shelter or facility.

ACE Asset (Comm - Satellite)

Satellite/multichannel (MUX) assets

ACE Assets (Command Platform)

The assets of the Marine Air Command And Control System provides the means for the ACE to effectively command MAGTF airspace and aviation assets. It includes assets of the: Tactical Air command Center, Tactical Air Direction Center, Tactical Air Operations Center and Early Warning/Control (EW/C) sites, Direct Air Support Center, and Marine Air Traffic Control Detachments.

ACE Assets (Control Platform)

The assets of the Marine Air Command And Control System provides the means for the ACE to effectively control MAGTF airspace and aviation assets. It includes assets of the: Tactical Air Command Center, Tactical Air Direction Center, Tactical Air Operations Center and Early Warning/Control (EW/C) sites, Direct Air Support Center, and Marine Air Traffic Control Detachments.

ACE Assets (Data Link)

The data link assets of the ACE include TADIL A, B, C, ATDL-1, point-to-point data links and LAN/WAN configurations.

ACE Assets (Data Link - TAOC(AN/TPS-59), ADCP, TAOC)

AN/TPS-59 Radar - the radar will be modified to provide increased ability to detect, track, and process TBM targets and distribute those targets to the TAOM. In the near-term configuration, the AN/TPS-59 is connected to a TAOC via fiber optic cable for passing air breathing target (ABT) information and to the light anti-air missile (LAAM) battalion's air defense communications platform (ADCP) via a point-to-point data link for passing TBM tracks.

ACE Assets (Data Link - TAOC, TACC, ADCP, BCP)

MACCS systems (TACC, DASC, MACALS, ADCP/BCP) and other service/allied C2 systems.

ACE Assets (MACCS)

The assets of the Marine Air Command And Control System provides the means for the ACE to effect command and control of MAGTF airspace and aviation assets. It includes assets of the: Tactical Air Command Center, Tactical Air Direction Center, Tactical Air Operations Center and Early Warning/Control (EW/C) sites, Direct Air Support Center, and Marine Air Traffic Control Detachments.

ACE Assets (Mobility Requirements)

This includes all of the equipment to move, transport and remain in a mobile status.

ACE Assets (Resolved Shortfalls)

This category identifies that the difference between the assets required to support the AAW mission and the assets organic to the ACE that are available has been resolved.

ACE Assets (RSTA)

This includes all organic Reconnaissance, Surveillance, and Target Acquisition assets of the ACE.

ACE Assets (Sensors)

This category includes all sensors organic to the ACE. Included are the COMINT, ELINT, Photo, Radar, and Visual observations. The An/TPS-59 is the only radar modified for TBM tracking.

Through radar inputs from its organic sensors and data link information from other military radar units (MRU), the TAOC provides real-time surveillance of assigned airspace in addition to air direction, positive aircraft control, and navigational assistance to friendly aircraft. Its primary function, to conduct and coordinate anti-air warfare (AAW), is accomplished through the direction, coordination, and employment of various air defense weapons systems which include interceptor aircraft and ground based air defense (GBAD) weapons.

ACE Assets (Shortfalls) C2 & Weapons

This category identifies the difference between the C2 & Weapon assets required to support the AAW mission and the assets organic to the ACE that are available.

ACE Assets (Shortfalls) - Communications

This category identifies the difference between the C2 & Weapon assets required to support the AAW mission and the assets organic to the ACE that are available.

ACE Assets (Shortfalls) - Mobility Required

This category identifies the difference between the required equipment to move, transport and remain in a mobile status to support the designated AAW mission and the mobility assets organic to the ACE that are available.

ACE Assets (Shortfalls)

This category identifies the difference between the assets required to support the AAW mission and the assets organic to the ACE that are available.

ACE Assets (Tankers)

Orbit areas (AEW/CAP/tankers/CAS stacks/EA/ES).

ACE Assets (Voice, Data)

Voice 2002 - Communications: the SOF and the TAOC are normally physically or electronically co-located, hence certain communication assets may be shared. The SAAWC and SAAWC staff require reliable means of communication with the TAOC, higher, adjacent, and subordinate air defense agencies. Communications within the SOF may include:

(1) Digital subscriber voice terminal (DSVT).

(2) Digital nonsecure voice terminal (DNVT).

(3) Secure telephone unit (STU) III (secure voice).

(4) Intercommunication system (ICS).

(5) Ultra-high frequency (UHF) radio(s) and crypto (KY-57/58).

(6) Very-high frequency (VHF) radio(s) and crypto (KY-57/58).

(7) High frequency (HF) radio(s) and crypto (KY-75/advanced narrow band digital voice terminal [ANDVT]).

(8) Satellite/multichannel (MUX) assets.

(9) AN/GRA-39 (for remote access, hot lines, etc.).

ACE Assets (Weapons - Siting Options)

To be determined.

ACE Assets (Weapons)

This category includes all AAW weapons available to the ACE. It also includes strike weapons that support the OAAW mission.

Its primary function, to conduct and coordinate anti-air warfare (AAW), is accomplished through the direction, coordination, and employment of various air defense weapons systems which include interceptor aircraft and ground based air defense (GBAD) weapons.

ACE Battlestaff

Conducting air defense specific planning to support the ACE battlestaff in preparing the air defense portions of operation orders to include:

- Identifying critical assets, vital areas, and air defense priorities.
- Coordinating the preparation of the ACE surveillance plan.
- Establishing and coordinating air defense communication requirements.
- Recommending air defense control measures.
- Recommending the utilization of allocated air defense weapons platforms.
- Ascertaining availability of air-to-air missiles (AAM) and surface-to-air missiles (SAM) and developing specific requirements for a resupply plan.
- Coordinating establishment of airspace management/control procedures.
- Planning for the tactical redeployment/alternate siting of AAW assets in response to changes in the surveillance plan, the threat, or the ground force positions.
- Identifying the need for airborne early warning (AEW) aircraft to the ACE/Marine air control group (MACG) to supplement radar coverage.

ACE Battlestaff (ACE Commander)

The ACE commander, his staff, and the MACCS, as the MAGTF's air operations and AAW experts, provide joint or combined force planners with the MAGTF's AAW capabilities and requirements. They also identify MAGTF capabilities and requirements relative to airspace control and air defense operations. Specifically, joint and combined operational plans must:

(1) Integrate and complement the mission of the joint force.

(2) Ensure the interoperability of equipment and personnel.

(3) Ensure the common use and understanding of terminology.

(4) Allow responsiveness and the massing of firepower whenever and wherever needed.

(5) Identify the proper liaison and staff/agency representation between joint force components. (Representatives from each component must enable and improve the information flow and provide expertise.)

(6) Outline procedures for airspace control and air defense degradation.

(7) Facilitate transition from peacetime conditions to hostilities.

ACE Battlestaff (ACLO) - Air Control Liaison Officer

A member of the TACC (FOS) who is responsible for advising the G-3/S-3 on air control issues to include:

- Coordinating with senior and subordinate air defense control agencies.
- Recommending the tactical employment of air and surface AAW means.
- Planning and coordinating with services concerning SAW matters.
- Planning and coordinating with adjacent, higher, and external HQs on OAS and Assault Support control matters.

ACE Battlestaff (ADC) - Air Defense Coordinator

Responsible to the Senior Air Coordinator for coordinating Air Defense within the MAGTF area of responsibility. (FMFM 5-60)

ACE Battlestaff (ASC) - Air Support Coordinator

Responsible to the Senior Air Coordinator for coordination of OAS and assault support within the MAGTF area of responsibility. (FMFM 5-60)

ACE Battlestaff (C2W Plans Officer)

A member of the TACC (FOS) who:

- Coordinates and establishes priorities between EW and signals intelligence missions.
- Coordinates lethal and nonlethal EW with the Weapons Employment Officer (WEO) to ensure that jamming, electronic deception, and destructive EW are integrated with other aviation weapons.

- Coordinates with communications-electronics officer (CEO) to ensure effective use of the electromagnetic spectrum.

- Prioritizes the target requirements of enemy electronic emitting agencies that may influence the MAGTF's capabilities to conduct operations. (FMFM 5-60)

ACE Battlestaff (Frequency Manager)

Initial Planning - After receipt of an initiating directive from the MAGTF commander (in situations involving amphibious operations) or after receiving an operation plan 's (OPLAN) initiating order, the SAAWC and TAOC staffs will begin the initial planning phase. Considerations for the initial planning phase include:

a. Establishing early liaison and initiating coordination efforts with amphibious task force (ATF) and joint force planners and coordinating with adjacent and subordinate units for operational execution.

b. Identifying communication requirements for subordinate, adjacent, and higher level circuits with the aviation combat element (ACE)/MAGTF communications planners. These requirements should include identification of desired connectivity, encryption hardware and software, and authentication materials.

c. Coordinating all frequency requirements (voice, data, radars) for subordinate, adjacent, and higher level circuits with the ACE/MAGTF communications planner.

ACE Battlestaff (FOS)

TACC's future operations section (FOS).

ACE Battlestaff (FWF) - Fixed Wing Fragger

A member of the TACC (FOS) who is responsible to the G-e/S-3 for detailed planning and tasking of fixed wing aircraft and also:

- Plans the required number of sorties for air interdiction.

- Plans and estimates the availability of air assets for the AAW concept.

- Plans sorties for OAS.

- Plans the required number of sorties for CAS.

- Computes excess/required sorties for fixed-wing assets and forwards them to the G-3/S-3 Watch Officer.

- Assists in the preparation of the ATO. (FMFM 5-60)

ACE Battlestaff (G-3/S-3 Watch Officer)

Senior watch officer in the TACC (FOS). He is responsible for all matters relating to the prosecution of future air operations. He performs the following duties:

- Coordinates and supervises the detailed planning and resource allocation of ACE units by the FOS for future operations, to include development of the ATO(s) and FRAGOs.

- Maintains situational awareness on the friendly situation, both air and ground.

- Evaluates the tactical situation and advises the operations section in the ACE HQ in the preparation of operation estimates, operations plans and orders, and operational and historical reports.

- Coordinates with the G-2/S-2 for the employment of intelligence systems and for updates on the enemy situation, to include establishing EW priorities.

- Establishes priorities for allocation of personnel, weapons, equipment, and ammunition in short supply.

Exchanges information with the COS and the planners in the ACE HQ on the status of current and future operations. (FMFM 5-60)

ACE Battlestaff (G-6)

The Communications and Electronics Officer who assists in ACE communications planning.

ACE Battlestaff (ICO) - Interface Coordination Officer

Responsible to the Senior Air Coordinator in the TACC for ensuring and accurate situation display and orderly functioning of all data links and data interfaces. He performs the following duties:

- Ensures the accurate and timely publishing of coordinating instructions for data link employment.

- Establishes surveillance sectors for suitably equipped platforms commensurate with their surveillance capabilities.

- Assigns the responsibility for establishing and reporting special points for interface among all link participants.

- Ensures that surveillance/identification procedures are published and executed.

- Utilizes data filters to protect participating units' data base without degrading the air situation display.

- Monitors TADILS and makes or recommends changes as necessary to ensure the best link quality.

ACE Battlestaff (IWO) - Intelligence Watch Officer

A member of the TACC organization, but not specifically included as a member of the TACC (COS or FOS). He is responsible to the Senior Watch Officer for maintaining an accurate display of the enemy situation, both air and ground. Supporting the COS, he advises the FOS on possible enemy courses of action as a result of current operations. He also:

- Ensures that the intelligence status boards and data bases are current and keeps the Senior Watch Officer on any changes.

- Coordinates with the ACE G-2/S-2 watch officer and the intelligence watch officers of aircraft groups and squadrons for mission planning EEIs.

- Coordinates intelligence operations with external agencies.

- Coordinates photo and sensor imagery requests and tasking.

- Disseminates intelligence information to subordinate agencies and units.

- Exchanges information with FOS and the Operations Planners in the ACE HQ on the enemy status in current operations. (FMFM 5-60)

ACE Battlestaff (MACCS (DASC))

SAAWC Role in Amphibious Operations - During an amphibious operation, MACCS air command and control (C2) facilities, whose functions parallel those of the Navy's air control agencies afloat, are established ashore. Once operational ashore, these MACCS agencies initially operate in a standby status, monitoring appropriate communications circuits and acquiring situational awareness in preparation for assuming control of their particular air control functions. Normally, once a particular MACCS facility (DASC, TAOC, etc.) is completely operational, to include appropriate equipment and communications circuits, the commander, landing force (CLF) will request from the commander, amphibious task force (CATF) that control of that function be passed from the appropriate naval agency afloat to the MACCS agency ashore. After passage of a particular control function ashore, the naval agency afloat will continue to monitor appropriate communication circuits and remain ready to résumé active control in the event this becomes necessary. The operation order will state exactly what prerequisites must be met (i.e., checklists) prior to accomplishing the passage of control ashore and how the passage of control ashore will be accomplished.

ACE Battlestaff (MWCS) - Marine Wing Communications Squadron

Primary communications organization within the ACE. Specifically it:

- Provides technical assistance in planning of ACE communications for command and control of MAGTF aviation assets.

- Provides all backbone multichannel and digital trunking/switching system links between the ACE command, agencies of the MACCS and forward operating bases.

- Provides message center services for the TACC.

- Provides tactical automated switching and telephone services to the TACC and ACE headquarters.

- Provides communications control for the ACE.

ACE Battlestaff (SAC) - Senior Air Coordinator

The senior MACCS watch stander in the current operations section of the TACC. He is responsible for execution of current operations through the MACCS.

ACE Battlestaff (SJA) - Staff Judge Advocate

Although not a normal participant in the ACE Battlestaff or TACC staff, in TMD operations, the SJA would be expected to provide legal services.

ACE Battlestaff (TAWO) - Tactical Air Watch Officer

The TAWO is responsible to the SAC for matching fixed-wing assets with requirements. (FMFM 5-60)

ACE Battlestaff (TDC) - Track Data Coordinator

The TDC is responsible to the Senior Air Coordinator in the TACC for track coordination within the MACCS and other tactical data systems. He performs the following duties:

Provides track coordination within the MACCS and other tactical Data systems by:

- Resolving track reporting conflicts referred to him for action.
- Resolving dual track designations.
- Initiating drop track orders.
- Resolving identification conflicts.
- Initiating Handover Orders.
- Selectively readdressing incoming/outgoing orders.
- Ensure proper use of manual cross tel procedures.
- Recommend changes to data link configuration.
- Ensures that the data link picture is an accurate presentation of the current air operations.
- The TDC's function may be combined with that of the ICO depending on the intensity of the operation and the number of track data system participants. (FMFM 5-60)

ACE Battlestaff (WEO) Weapons Employment Officer

A member of the TACC (FOS) who advises the G-3/S-3 on the best utilization of Aviation weapons. He performs the following:

- Advises the G-3/S-3 watch officer of the most efficient employment of all of the wing's aviation ordnance assets.

- Works directly with the Fixed Wing Fragger and Rotary Wing Fragger. Recommends ordnance requirements based on available target information for current and future operations.

- Provides weponeering data for CAS, DAS, interdiction, and SEAD/offensive anti-air Warfare (OAAW) missions.

- Performs target analysis for nuclear/chemical munitions and coordinates all related mission planning.

- Coordinates with the command and control Warfare (C2W) plans officer on EW targeting and employment procedures. (FMFM 5-60)

ACE C3 Architecture

The ACE C3 Architecture refers to the command, control and communications architecture that is created to support AAW in general and TMD in specific. It includes all data and voice communications.

ACE C3 Architecture (C2 Option)

To be determined.

ACE C3 Architecture (Casualty Option)

To be determined.

ACE C3 Architecture (COMM Net & Freq Assign)

Refers to the Communications Nets that are required and the Frequency(ies) assigned to them.

ACE C3 Architecture (Connectivity)

Refers to which agencies or tactical assets can communicate via the ACE C3 Architecture to another unit also within or connected to the architecture.

ACE C3 Architecture (Data Option)

The data portion of the architecture which will include ground based data links, TADIL A, TADIL B, and TADIL J among others.

ACE C3 Architecture (Facility Location)

The location of a facility that provides support to the ACE C3 architecture.

ACE C3 Architecture (JTIDS) Joint Tactical Information Distribution System

JTIDS will be used by TMD agencies to coordinate TMD operations.

ACE C3 Architecture (Status)

The current status of the C3 architecture. Includes participants, quality of communications and alternate communication capabilities.

ACE C3 Architecture (TADIL) Tactical Digital Information Link

Until all ACE AAW agencies and/or assets become JTIDS capable. TADIL A will provide the main source of communicating TMD operations with the TACC and TAOC.

ACE C3 Architecture (Voice Options)

Communications - The SOF and the TAOC are normally physically or electronically co-located, hence certain communication assets may be shared. The SAAWC and SAAWC staff require reliable means of communication with the TAOC, higher, adjacent, and subordinate air defense agencies. Communications within the SOF may include:

(1) Digital subscriber voice terminal (DSVT).

(2) Digital nonsecure voice terminal (DNVT).

(3) Secure telephone unit (STU) III (secure voice).

(4) Intercommunication system (ICS).

(5) Ultra-high frequency (UHF) radio(s) and crypto (KY-57/58).

(6) Very-high frequency (VHF) radio(s) and crypto (KY-57/58).

(7) High frequency (HF) radio(s) and crypto (KY-75/advanced narrow band digital voice terminal [ANDVT]).

(8) Satellite/multichannel (MUX) assets .

(9) AN/GRA-39 (for remote access, hot lines, etc.).

ACE Capabilities

This identifies the combat capabilities of the ACE. It identifies the ACE's ability to conduct AAW and TMD.

ACE Capabilities (Data Link)

The data portion of the architecture which will include ground based data links, TADIL A, TADIL B, and TADIL J among others.

ACE Capabilities (IADS/Personnel)

The mental and tactical capabilities of the integrated air defense personnel assigned to the ACE staff and the System technical capabilities.

ACE Capabilities (Relative Combat Power)

This includes an examination and comparison of opposing forces which involves an assessment of communication and electronics capabilities, logistic support, and time and distance factors. (FMF 5-5)

ACE Capabilities (Sensor)

The capability of the sensor under discussion. Includes such items as range, resolution, field of view, and accuracy.

ACE Capabilities (System)

The physical and tactical capabilities of the integrated air defense systems technical capabilities assigned to the ACE staff.

ACE Capabilities (System/Weapon Performance)

The physical and tactical performance capabilities of the integrated air defense systems and weapons technical capabilities assigned to the ACE staff at a given time. This is normally less than their advertised capability.

Non-material Alternatives. Changes to doctrine, organization, training/education or tactics will not adequately fulfill this need. Current doctrinal concepts maximize the effectiveness of the present surface-to-air weapons systems. The present system has demonstrated inadequacies in weapons performance, firepower, mobility, logistics and maintenance. Current training methods have proved effective in maximizing current equipment capabilities but can not address the physical limitations of the weapons system. Present tactics maximize the effectiveness of current MAGTF low to medium altitude air defense assets. However, the technological advances in attack aviation have System Performance. The SOF will provide automated assistance, in the form of informational and tabular displays, to the SAAWC and staff personnel in the conduct of AIR OPS for the MAGTF operational forces. The SOF will be able to support fixed-site long-term SAAWC operations and periodic short-duration Alt TACC operations. The SOF must be capable of employment across the entire operational continuum . The SOF will enhance the capability of the TAOC to manage and coordinate all AIR OPS activities to include TMD operations. Enhancements to the TAOC battle management, surveillance, intelligence, and weapons control functions will be provided through hardware, software, and communications improvements provided by the SOF. The SOF will interface with required equipment to establish the Alt TACC configuration. All Alt TACC personnel need not operate from the SAAWC shelter. The AN/TYQ-23(V)1 will interface with the SOF for the exchange of data, and these interfaces will employ an open architecture operating system expanding to the Global Command and Control System (GCCS) and Common Operating Environment (COE).

General system requirements. To achieve the desired capability, the SOF will provide the below performance:

a. Support

1. System initialization.

2. System administration.

3. Network configuration and management.

4. Performance monitoring.

5. Voice and data communications.

6. Interfaces to other systems.

7. Security System.

b. Design and Construction

1. Accessibility of functions from any SOF workstation (objective).

2. Common Operating Environment.

3. Utilize Commercial Off-The-Shelf/Government Off-The-Shelf (COTS/GOTS) equipment .

4. Equipment packaged for transport to ensure survivability, flexibility, and ease of deployment.

5. Utilize existing systems/prototypes, as appropriate.

6. SOF workstations and equipment will be removable to allow remote operations mode four hundred meters (seven-hundred and fifty meters objective) from the host AN/TYQ-23(V)1. The SOF will also be capable of being set up within its own enclosure to provide a work space with at least three-hundred square feet (four-hundred and fifty square feet objective) of floor space in a rectangular configuration.

7. Use available GCCS compliant software systems to include applicable software segments of Joint Maritime Command Information System JMCIS), Tactical Combat Operations (TCO), Intelligence Analysis System (IAS) and display the required DMA digital maps.

8. Use existing TAOC communications to maximum extent.

9. Provide migration to Global Command and Control System (GCCS).

c. Monitor Intelligence Situation

1. Analyze intelligence/threat situation

(a) Perform area delimitation/terrain analysis/radar coverage analysis.

(b) Perform Intelligence Preparation of the Battlefield (IPB).

(c) Receive/process/display near-real-time GENSER threat data (JMCIS, CIS, TIBS/TRAP).

(d) Receive/process/display other digital or manually entered threat data.

(e) Receive/display/annotate order-of-battle data.

(f) Receive/display/annotate secondary imagery data and orient this information to the tactical situation display (objective).

(g) Perform multi-intelligence data correlation (objective).

(h) Perform multi-source Combat ID data correlation (objective).

(i) Receive/display weather information (imagery objective).

2. Prepare/edit/transmit request for intelligence updates

3. Provide integrated intelligence/operations situational display

d. Monitoring of TAOC weapons control functions

1. Threat ranking (air and ground targets).

2. Weapons cuing.

3. Weapons coordination.

4. Weapons assignment/control.

e. Automated mission monitoring status

1. Receive, display, store, parse, process, and forward the ATO and ACO (to include all updates):

(a) Tasking.

(b) Resource allocation.

(c) Target priorities.

(d) Processing will include deconfliction of airspace control measures.

2. Monitor resource status (fuel, weapons, equipment and airfield status).

3. Monitor execution or status of missions/schedules.

f. Monitor air defense situation

1. Receive/display air situation data (process objective):

(a) Local and remote air track data (TAOC, CRC, AWACS, AEGIS, and other available sources).

(b) Local and remote passive sensor data.

(c) TADIL and surface-to-air unit locations.

2. Exchange air situation data with required MAGTF units via WAN (objective).

g. Monitor friendly ground situation

1. Receive/store/process/display ground track data required for the SAAWC to plan and conduct AAW operations (Joint Surveillance Target Attack Radar System (JSTARS), TCO, IAS).

2. Exchange ground situation data with required MAGTF units via WAN (objective).

h. Monitor and disseminate missile defense situation

1. Receive/display missile situation data.

(a) Receive/display local sensor data (AN/TPS-59).

(b) Receive/display missile track data from remote sources.

2. Display correlated view of missile track data (launch point, impact point, and missile track) and air track data (objective).

3. Transmit missile track data to appropriate TMD agencies and disseminate missile warning information (passive defense) as appropriate.

4. Receive and display missile defense unit locations and engagement zone information.

i. Conduct Alt TACC operations

1. Provide necessary Alt TACC communications interfaces (with augmentation).

2. Provide limited ATO generation capability (with TACC augmentation).

3. Monitor all required SOF situational displays/unit communications with he addition of air support requirements (with TACC augmentation).

ACE Capabilities (Tanking)

To be determined.

ACE Capabilities (Weapons Utilization Rate)

The rate at which a weapon can be fired and returned to a state ready to fire again. Also provides a sense of ordnance utilization rate.

ACE Capabilities (Weapons, C2 Platform/Facilities & Sensors)

ACE Capabilities Weapons + ACE Assets C2 Platforms + ACE Capabilities Sensors.

ACE Capabilities (Weapons)

The physical and tactical capabilities of the integrated air defense weapons technical capabilities assigned to the ACE staff.

ACE Commander

The ACE commander, his staff, and the MACCS, as the MAGTF's air operations and AAW experts, provide joint or combined force planners with the MAGTF's AAW capabilities and requirements. They also identify MAGTF capabilities and requirements

relative to airspace control and air defense operations. Specifically, joint and combined operational plans must:

(1) Integrate and complement the mission of the joint force.

(2) Ensure the interoperability of equipment and personnel.

(3) Ensure the common use and understanding of terminology.

(4) Allow responsiveness and the massing of firepower whenever and wherever needed.

(5) Identify the proper liaison and staff/agency representation between joint force components. (Representatives from each component must enable and improve the information flow and provide expertise.)

(6) Outline procedures for airspace control and air defense degradation.

(7) Facilitate transition from peacetime conditions to hostilities.

Air Control/Air Direction Authority

Airspace control sectors are designated in accordance with procedures and guidance contained in the airspace control plan in consideration of component, host nation, and allied airspace control capabilities and requirements.

Air Order Of Battle (AOB)

Activities related to not only collecting the encyclopedic-type data on airframe capabilities and limitations, but will also include enemy's ordinance capabilities, their extent of training and morale, their likely tactics, and their intended priority targets. The potential UAV Threat must also be considered since enemy UAVs may be used as targeting, jamming or reconnaissance platforms. They may also be used as drones to stimulate. The MAGTF Integrated Air Defense System and make it susceptible to anti-radiation missiles. (MACCS Tactical Planning Guide)

Air Superiority Required

Air Defense Specific Planning - The ACE staff will normally augment several air defense specialists to assist in the preparation of the MAGTF operations order. Critical decisions, to include air defense apportionment and planning to achieve air superiority must be addressed and answered during this phase. The preliminary site selections for air defense agencies (TAOC, HAWK) are also finalized. Other planning efforts include:

Air Superiority - That degree of dominance in the air battle of one force over another which permits the conduct of operations by the former and its related land, sea, and air forces at a given time and place without prohibitive interference by the opposing force. (Joint Pub 1-02)

Mission - MAGTFs deploy worldwide and are involved in the full spectrum of conflict. Air defense is necessary for the MAGTF to establish air superiority and protect the force from air attack. Air superiority allows the MAGTF the freedom to maneuver and subsequently position itself to defeat the threat. The mobile surface-to-air missile system will be required to provide very low to medium altitude/close to medium range air defense for the entire MAGTF. The system must be capable of defeating the full spectrum of air threats from tactical ballistic missiles to low radar cross section cruise missiles and unmanned aerial vehicles. The deficiencies in this mission area are outlined in Mission Area Analysis (MAA) 32, (Anti-air Warfare (S)) specifically deficiencies: Active Defense 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 16 and 19/Passive Defense 1, 2, 4 and 5. This need is also identified in the MAGTF Air Defense Study of 26 July 1991.

Airspace Control Request (ACR)

The document used to request airspace control measures. The ACR provides the airspace control authority with detailed airspace requirements, which if approved, are included in the ACO.

Allocation Request

Allocation Request (ALLOREQ) - a message or voice request from the ACE commander to the MAGTF commander requesting air units allocation.

Allocation Shortfall

To be determined.

AN/TPS-59

AN/TPS-59 Radar Set. The AN/TPS-59 (Figure 2-2) is a solid state radar designed to provide long-range (300 nautical mile) surveillance. The AN/TPS-59 is a 3 dimensional (bearing, range, and target altitude), linear phased array radar which operates in the D band (1215 - 1400 megahertz [MHZ]). The radar set consists of three computer shelters and an antenna which is transported on three single-axle trailers. The radar control shelter accommodates two position display consoles which are capable of providing a planned position indicator (PPI) display, range height indicator (RHI) display, or both displays simultaneously. The radar's 54 transmitters are arranged in 54 rows and operated independent of each other which allows redundancy. 16 rows can be non-operational before

the radar is considered degraded. The AN/TPS-59 also has the capability of operating in the 2 dimensional mode should its general purpose computer fail. The AN/TPS-59 radar suite includes four ARM decoy pallets. Theater missile defense (TMD) enhancements to the AN/TPS-59 radar will improve its range and altitude detection capabilities to 400 nautical miles and 500,000 feet respectively.

Approved Plans

To be determined.

Approved Plans (ACE Surveillance)

Establishing coordination for and preparation of the ACE surveillance plan. The ACE surveillance plan provides the foundation for all subsequent air defense operations and should consider all available means (electronic or visual) to detect, identify, and track air vehicles in the MAGTF's area of operations (AO). While the location of individual elements of the surveillance system (TAOC and HAWK radars, combat air patrols [CAP], airborne early warning [AEW], Stinger teams, etc.) will be influenced by many operational and topographical factors, every effort should be made to provide detection capabilities at all altitudes throughout the AO, with particular emphasis on likely threat avenues of approach. Overlapping and redundant surveillance coverage should be achieved where possible and a reliable, swift and redundant communications plan should also be devised to ensure rapid dissemination of detections.

Conducting air defense specific planning to support the ACE battlestaff in preparing the air defense portions of operation orders to include:

- Identifying critical assets, vital areas, and air defense priorities.

- Coordinating the preparation of the ACE surveillance plan.

- Establishing and coordinating air defense communication requirements.

- Recommending air defense control measures.

- Recommending the utilization of allocated air defense weapons platforms.

- Ascertaining availability of air-to-air missiles (AAM) and surface-to-air missiles (SAM) and developing specific requirements for a resupply plan.

- Coordinating establishment of airspace management/control procedures.

- Planning for the tactical redeployment/alternate siting of AAW assets in response to changes in the surveillance plan, the threat, or the ground force positions.

- Identifying the need for airborne early warning (AEW) aircraft to the ACE/Marine air control group (MACG) to supplement radar coverage.

Approved Search Procedure

To be determined.

AO

Area of Operations - That portion of an area of war necessary for military operations and for the administration of such operations. (Joint Pub 1-02) Also called AO.

Establishing coordination for and preparation of the ACE surveillance plan. The ACE surveillance plan provides the foundation for all subsequent air defense operations and should consider all available means (electronic or visual) to detect, identify, and track air vehicles in the MAGTF's area of operations (AO). While the location of individual elements of the surveillance system (TAOC and HAWK radars, combat air patrols [CAP], airborne early warning [AEW], Stinger teams, etc.) will be influenced by many operational and topographical factors, every effort should be made to provide detection capabilities at all altitudes throughout the AO, with particular emphasis on likely threat avenues of approach. Overlapping and redundant surveillance coverage should be achieved where possible and a reliable, swift and redundant communications plan should also be devised to ensure rapid dissemination of detections.

The JFC normally assigns responsibility for JTMD attack operations outside the component commander's AOs to the joint force air component commander (JFACC), if the JFC designates a JFACC. The JFC normally tasks component commanders to conduct JTMD attack operations within their assigned AOs.

AOI

Area of Interest (AOI) - provides airspace control, management, and surveillance for its designated sector or area of interest (AOI).

Applications Broadcast (TIBS/TRAP)

Special purpose broadcasts that provides time-critical sensor reports to the intelligence community. It is a one -way data link.

Artillery

Artillery organic to, under the control of, or available for use by the ACE, MAGTF, or JTF as indicated. Artillery is considered available if it is in an operational ready status and is not being utilized by another mission. Artillery would also be available if the current missing was of higher priority and the Artillery could be diverted to the desired mission.

Asset Availability

An asset is organic to or under the control of the ACE, MAGTF, or JTF as indicated. An asset is considered available if it is in an operational ready status and is not being utilized by another mission. An asset would also be available if the current mission was of higher priority and the asset could be diverted to the desired mission.

Asset Availability (ACE - Aircraft, Missiles, & UAVs)

An Aircraft, Missiles, & UAVs organic to or under the control of the ACE, MAGTF, or JTF as indicated. An Aircraft, Missiles, & UAVs is considered available if it is in an operational ready status and is not being utilized by another mission. An Aircraft, Missiles, & UAVs would also be available if the current missing was of higher priority and the Aircraft, Missiles, & UAVs could be diverted to the desired mission.

Asset Availability (ACE Communication)

A communication system organic to or under the control of the ACE, MAGTF, or JTF as indicated. A communication system is considered available if it is in an operational ready status and is not being utilized by another mission. A communication system would also be available if the current mission was of higher priority and the communication system could be diverted to the desired mission.

Asset Availability (ACE - Aircraft)

An aircraft organic to or under the control of the ACE, MAGTF, or JTF as indicated. An aircraft is considered available if it is in an operational ready status and is not being utilized by another mission. An aircraft would also be available if the current mission was of higher priority and the aircraft could be diverted to the desired mission.

Asset Availability (Aircraft, Missiles, UAVs)

Same definition as Asset Availability (ACE - Aircraft, Missiles, & UAVs). An Aircraft, Missiles, & UAVs organic to or under the control of the ACE, MAGTF, or JTF as indicated. An Aircraft, Missiles, & UAVs is considered available if it is in an operational ready status and is not being utilized by another mission. An Aircraft, Missiles, & UAVs

would also be available if the current mission was of higher priority and the Aircraft, Missiles, & UAVs could be diverted to the desired mission.

Asset Availability (Host Nation)

A host nation that allows the organic assets under the control of the ACE, MAGTF, or JTF to reside in its territory. A host nation is considered available if it is operationally ready to receive assets.

Asset Availability (JTF, MAGTF)

An asset is organic to or under the control of the ACE, MAGTF, or JTF as indicated. An asset is considered available if it is in an operational ready status and is not being utilized by another mission. An asset would also be available if the current mission was of higher priority and the asset could be diverted to the desired mission.

Asset Availability (Land-lines)

A land-line (communication path of copper or fiber optic) organic to, under the control of, or available for use by the ACE, MAGTF, or JTF as indicated. A land-line is considered available if it is in an operational ready status and is not being utilized by another mission. A land-line would also be available if the current mission was of higher priority and the land-line could be diverted to the desired mission.

Asset Availability (MAGTF - Artillery)

MAGTF - Artillery organic to or under the control of the ACE, MAGTF, or JTF as indicated. MAGTF - Artillery is considered available if it is in an operational ready status and is not being utilized by another mission. MAGTF - Artillery would also be available if the current mission was of higher priority and the MAGTF - Artillery could be diverted to the desired mission.

Asset Availability (Radio Equipment)

Radio communications equipment organic to or under the control of the ACE, MAGTF, or JTF as indicated. Radio communications equipment is considered available if it is in an operational ready status and is not being utilized by another mission. Radio communications equipment would also be available if the current mission was of higher priority and the Radio communications equipment could be diverted to the desired mission.

Asset Availability (Satellites)

Satellites available to the ACE, MAGTF, or JTF as indicated. A satellite is considered available if it is in an operational ready status and is not being utilized by another mission. A satellite would also be available if the current mission was of higher priority and the satellite could be diverted to the desired mission.

Asset Availability (Sensors)

Sensors available to the ACE, MAGTF, or JTF as indicated. A sensor is considered available if it is in an operational ready status and is not being utilized by another mission. A sensor would also be available if the current mission was of higher priority and the sensor could be diverted to the desired mission. The ACE has its own sensor and will have access to other sensors. This refers to all sensors available.

Asset Availability (Weapons)

Weapons available to the ACE, MAGTF, or JTF as indicated. A weapon is considered available if it and its delivery platform is in an operational ready status and is not being utilized by another mission. A weapon would also be available if the current mission was of higher priority and the weapon could be diverted to the desired mission. The ACE has its own weapons and delivery positions and will have access to other weapons. This refers to all weapons available.

BCP (Battery Command Post)

Houses the Tactical Display Console, the Radar Operator Console, the IFF system, the Automatic Data processing Equipment, communication equipment, and the data link encryption devices for a HAWK firing unit.

Battlespace

The Joint Task Force (JTF) approved battlespace assigned to the ACE commander.

Battlespace (AOI)

The resultant of activity A1.3.3. It is defined in that activity.

Battlespace (AO)

The resultant of activity A1.3.2. It is defined in that activity.

Command and Control

C2 - The exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating, and controlling forces and operations in the accomplishment of the mission. (Joint Pub 1-02) Also called C2.

Courses of Action

Tactical action or a combination of tactical actions that can be taken as a response to a threat stimulus.

Courses of Action (Planned)

Courses of action that, based upon initial intelligence and situation assessment, appear feasible.

Courses of Action (Planned & Supportable)

Planned courses of action that can be supported by ACE assets and logistics capabilities.

CST Reference Plane

The common space and time reference plane that will be used for data transformation.

CTAPS

To be determined.

Combat Service Support Request

To be determined.

Commander (CAP)

To be determined.

Control & Coordination Measures

Measures used to control and coordinate airspace and airspace users. They include fire support coordination measures, airspace control measures, and air defense control measures.

Control & Coordination Measures - Fire Support Coordination Line (FSCL)

A line established by the ground commander to ensure coordination of fire not under his control but which my affect current tactical operations.

Control & Coordination Measures (Airspace Control Measures)

Procedural control measures designed to maximize the effectiveness of combat operations by promoting safe, efficient and flexible use of airspace.

Control & Coordination Measures (Control Measures)

Established to maximize the effectiveness of air defense operations while minimizing interference with other operations. (FMF5-60)

Control & Coordination Measures (Vital Area)

A vital area is a designated area or installation to be defended by air defense units. It contains the facilities, units, and installations necessary for the landing force to accomplish its mission. The outward edge or boundary of the vital area is always the reference point in applying destruction-in-depth principles. There may be one or more vital areas, depending on the scope of the operation. The following factors are examined in determining and designating vital areas:

- The probable method of air delivery.

- The anticipated weapons to be used by an enemy.

- The addition of an overall standoff range to the outside edge of the defended complex. After the vital area boundary is determined, it becomes the range by which enemy air attacks must be destroyed to prevent damage to the vital area. In the event of an enemy nuclear, biological, or chemical (NBC) capability, standoff ranges will be expanded to include the delivery capability for his largest weapon.

Cryptographic Considerations

Considerations such as time for changing, availability of keys that support all of the agencies involved, and equipment compatibility.

Current Mission Objective

To be determined.

DASC (Direct Air Support Center)

The DASC is responsible for directing air operations directly supporting ground forces and processing immediate air support requests. For TMD operations, the TAOC or TACC would coordinate with the DASC for aircraft that would be available to be diverted to OAAW missions.

Decision Aids

This category identifies those systems or tools that assist in the decision making process.

Decision Aids (EREPS)

To be determined.

Decision Aids (Manual)

To be determined.

Decision Aids (Map Study)

To be determined.

Decision Aids (System Software)

To be determined.

Decision Aids (TAMPS)

Producing/obtaining radar coverage diagrams from the tactical aviation mission planning system (TAMPS), Electronic Compatibility Analysis Center (ECAC) studies, or manual computations.

Decision Aids (Support)

To be determined.

Denied Request (Support)

To be determined.

Detectable Battlefield Phenomenon

Detectable Battlefield Phenomenon are those phenomenon detected that are not consistent with "normal" geographical or environmental conditions. Those phenomenon are detected by sensors such as unusual radar returns and are caused by unusual physical circumstances such as unusual lighting, shadowing effects, infrared (heat) and electrical conditions such as static charge buildup.

Doctrine

Publications that provide guidance in given area. See the specific doctrinal publication for specifics.

Doctrine (FMFM 3-30)

Doctrine- provides guidance in communications.

Doctrine (Joint Pub 3-01.5)

Joint Theater Missile Defense Publications that provide guidance in the TMD area.

Doctrine (Joint Pub 3-56.21)

Publications that provide guidance in given area. See the specific doctrinal publication for specifics.

Engagement Order

To be determined.

Engagement Order (JTAR 9 Line Brief)

To be determined.

Engagement Quality Targeting Information

Targeting information sufficient to complete an AOOW mission including target acquisition for weapon delivery.

Engagement Quality Track Information

Targeting information that is within the threshold for the weapon launch platform to launch the weapon and hit the target.

FMFM 5-5

The hostile capability to exploit news media releases and technical publications divulging information relative to weapons, tactics, and operations and to exploit unclassified military communications, such as weather and flight plan traffic, by overt means.

FMFM 5-60

FMFM 5-60 (control of aircrafts and missiles) - because of differences in organization and functioning regarding SAAWC operations, the Marine Corps has reiterated and further defined the SAAWC operational concept in FMFM 5-60 Control of Aircraft and Missiles, and established SAAWC- level Marine Corps Combat Readiness Evaluation System (MCCRES) mission performance standards (MPS).

Air Control - The authority to effect the maneuver of aircraft. The elements of air control are: air control agency, air controller, airspace control, operational control, positive control, procedural control, radar control, and terminal control. (FMFRP 0-14) Air control is the authority to direct the physical maneuver of aircraft in flight or to direct an aircraft or SAW unit to engage a specific target. (FMFM 5-60)

Missile Engagement Zone - The airspace of defined dimensions within which the responsibility for engagement normally rests with missiles. (FMFM 5-60) Also called MEZ. MEZs may be designated within the missile intercept zone (MIZ).

Frequency /Bandwidth Availability

The amount of total bandwidth available for a given application and the frequency spectrum and number of frequencies available within the given spectrum.

GCE (Ground Combat Element)

The ground combat element conducts that ground war for the MAGTF commander. Coordination is required in all phases of TMD, but especially for OAAW operations.

GCE Fire Support Coordination Center (FSCC)

A single location in which centralized communications facilities and personnel incident to the coordination of all form of fire support. (FMFM 5-60)

The DASC must request release of airborne assets destined for CAS or DAS missions prior to diverting those aircraft to OAAW missions.

GCE (Scheme of Maneuver)

The ground scheme of maneuver is intertwined with the ACE location of weapons and C3 facilities. Also, the ACE must provide air defense for the MAGTF as a whole.

Ground Order Of Battle (GOB)

Activities related to collecting information on the threat s Surface to surface missile (SSM) threat. Specific areas to address when conducting the assessment of the threat s SSM capability include , location, range, accuracy, ability to rapidly displace and be ready to fire once again. Particular attention is given to the threat's mechanized capability, as it will likely impact on the siting of agencies which conduct the control of Aircraft and Missiles. (MACCS Tactical Planning Guide)

Guidance (ACE-Priorities & Intent)

This category involves the ranking by a commander of a number of elements of any situation in the order of each element's importance to the accomplishment of the mission. Priority information may involve establishing the precedence of elements relative to time, space, or any number of other limiting factors is an "if-then" relationship. (Joint Pub 3-56)

Guidance (JFC Guidance & Objectives)

The JFC-level guidance may include but is not limited to: A methodology for joint planning of JTMD. Priority for JTMD effort, for example, what types of targets are most important for attack operations and what friendly assets must be protected by active defense. Definition of the areas of operations (AO) of components. Apportionment is the capabilities/forces made available to the functional components. Guidance on component-to-component coordination to facilitate deconfliction and timely TMD operations is the role of the JFC's staff in coordinating JTMD activities. The degree of Joint Targeting Coordination, if established, involvement in TMD. (Joint Pub 3-01.5)

HAWK System

Provides medium range (2nm to 20nm against helos and fixed-wing) surface to air missile defense for assigned areas of operations, air installations, and vital areas against low and medium altitude (50 feet to over 50,000 ft) air attacks.

HAWK System (-PAR, -CWAR)

The Pulse Acquisition Radar and Continuous Wave Acquisition Radar are not required for TMD operations when the TPS-59 is linked through the ADCP.

HAWK System (ADCP) Air Defense Communication Platform

The ADCP will be used to provide interface for the HAWK to the AN/TPS-59 radar and to also provide JTIDS connectivity until the TAOC is capable.

HAWK System (BCP) Battery Command Post

Houses the Tactical Display Console, the Radar Operator Console, the IFF system, the Automatic Data processing Equipment, communication equipment, and the data link encryption devices.

HAWK System (Loader)

To be determined.

HAWK System (Re-loader)

To be determined.

HAWK System (TCO)

Tactical Combat Operations (TCO).

ID Threat

The threat track when acquired by the weapons platform will confirm the target's ID prior to destroying the target.

Identification Criteria

Coordinated measures which help provide timely identification include information from visual sightings, radar, IFF, flight plans, air corridors, flight characteristics, and, the actions of observed aircraft.

Friendly aircraft are those:

- Recognized as a friendly.
- In a friendly corridor not committing a hostile act.
- Designated by a control agency.
- Unidentified and not committing a hostile act.

Hostile aircraft are those:

- Recognized as an enemy.
- Unidentified and attacking friendly installations.
- Unidentified in areas where control agencies have specified all aircraft will be engaged.

Information

Information is symbols (e.g., numbers, letters, words, graphics, visual images, sounds, smells, or physical contact) whether they represent something concrete or abstract, that give visualization to convey a thought.

Information (Resolution/Accuracy)

A sense of how accurately the information represents the environment that it is attempting to describe.

Information Requirements

To be determined.

Information (Tactical Picture)

The information that portrays the current status of the battle space.

Initial Targeting Information

Targeting information sufficient to commence an AOOW mission but may not contain complete targeting identification.

Intelligence

Data that has been processed and compared with other sources to provide and accurate estimate of the threats capabilities or intentions.

Intelligence (FLTREP) - In-flight Report

The FLTREP is designed for use by pilots/crews to report tactical sightings or information obtained in flight that is of such importance and urgency that a delay in reporting the data might negate the usefulness of the information. In such cases, the information to be reported will be transmitted on designated frequencies to the appropriate agency.

Intelligence (HOTPHOTOREP) - Hot Photo Report

The HOTPHOTOREP form (Appendix I) provides a brief, concise, high-priority report on time-sensitive targets of significant tactical importance or of a perishable nature. This report is used to alert the joint force commander of a threat to friendly forces or of a significant, fleeting target requiring immediate operational consideration, resulting from a quick sensor readout. The HOTPHOTOREP is submitted either by voice or message, based on time and security requirements, and will be followed later by the Initial Photo Interpretation Report (IPIR). (JP 3-56.1)

Intelligence (Human)

The hostile capabilities and practices in the areas of espionage; subversion; exploitation of lost, captured, or misplaced documents; and prisoner interrogation.

Intelligence Report (INTREP)

The INTREP is prepared by the first intelligence processing element (normally battalion, squadron, or ship level) acquiring the information. The intent of the report is to provide information on events or conditions that may have an immediate and significant impact on current planning and operations, or may be of immediate interest at the national level. The INTREP will not be used in lieu of the Critical Intelligence Report (CRITIC) for reporting intelligence items covered by the CRITIC system. The INTREP may be prepared on any item of intelligence, regardless of source, and usually each report will address only a single item. The INTREP will be prepared using the standard format contained in Appendix K and will be given lateral as well as vertical dissemination. The value of the

report is in direct proportion to the timeliness of submission and precedence used for dissemination.

Intelligence Summary (INTSUM)

The INTSUM provides a summary of the intelligence situation covering a specific period of time specified by the joint force commander (usually 6 hours). Normally, the report will be prepared at battalion, wing, task group, and higher echelon. The format for the INTSUM is contained in Appendix L. The report will be prepared in message form and transmitted by appropriate means as determined by its urgency and content. Minimum dissemination will be the next higher, lower, and lateral echelon. Wider distribution will be as directed.

Intelligence (IPB DATA BASE)

Intelligence Preparation of the Battlefield is an analytical methodology employed to reduce uncertainties concerning the enemy, environment, and terrain for all types of operations. IPB builds an extensive database that for each potential area in which a unit may be required to operate. The data can be analyzed in detail to determine the impact of the enemy, environment, and terrain on operations and presents it in graphic form IPB is a continuing process. IPB Products are used to evaluate enemy capabilities, vulnerabilities, and probable courses of Actions. For TMD, the IPB shows the Commander when and where they can most effectively engage the enemy and contributes significantly to the process of area limitation analysis and ultimately to automated cuing of TMD sensors and weapons systems to threatening targets. IPB includes updating the TM data bases to maintain and provide near-real time status of selected enemy TM related capabilities (e.g., Order of Battle, operating bases, type, range , and employment techniques of available missiles and/or warheads; missile launch, load, hide, and support sites; Potential routes; intelligence and electronic warfare (IEW) systems; C2 nodes and enemy defenses. IPB drives the development of the collection plan, which in tern drives sensor types, collection windows, and areas of coverage. (Joint Pub 3-01.5)

Intelligence (IPIR)

The IPIR is designed to provide more detailed information than HOTPHOTOREP. The IPIR will be prepared within a time frame to meet command requirements as specified by the appropriate authority. The specific intelligence required should be transmitted to the requester in consonance with the urgency of the request. The IPIR will contain information on special mission objectives as well as fleeting/transient targets, newly identified activity of priority interest, militarily significant change to known installations observed during scan of the mission imagery, and such other requirements for information as may be requested by appropriate authority. Normally, it is the final report that is transmitted by the collection unit. The message Precedence of the report will be determined by the request priority and

the significance of the information. The IPIR format and preparation instructions are contained in DIAM 57-5, "DOD Exploitation of Multi-Sensor Imagery," Appendix B. "Format for First and Second Phase Reporting IPIR/SUPIR." (JP 3-56.1)

Intelligence (TIBS/TRAP)

To be determined.

Intelligence (Open Literature)

The hostile capability to exploit news media releases and technical publications divulging information relative to weapons, tactics, and operations and to exploit unclassified military communications, such as weather and flight plan traffic, by overt means (FMFM 5-5 Para).

JFC Staff (Political Advisor)

Advises JFC regarding assistance to HN or allied governments in developing passive air defense measures against TM attacks.

JTF Assets

To be determined.

JTF Staff

To be determined.

LAN/WAN Options

Voice and data communications connectivity with senior, adjacent, and subordinate air defense agencies using the TAOC's voice communications bus and/or externally introduced communications devices (e.g., remote radios, telephones, etc.). This capability will include LAN/WAN access.

Connectivity will be provided via LAN/WAN with other agencies.

The SOF will receive and parse the ACO from the TACC through the CTAPS LAN/WAN, USMTF, or diskette. The workstation will display the airspace control measures (ACMs) to the operator.

Land-line Options

To be determined.

Law

A rule established by authority, society, or custom expressing the precepts and principles applicable in a particular domain. (Ref. Webster's II New Riverside University Dictionary)

Law (Host Nation)

A rule established by authority, society, or custom expressing the precepts and principles applicable in the host nation. (ref. Webster's II New Riverside University Dictionary)

Law (USA)

A rule established by authority, society, or custom expressing the precepts and principles applicable in the USA and its armed forces. (ref. Webster's II New Riverside University Dictionary)

MACCS (Marine Air Command and Control System)

A system which provides the aviation combat commander with the means to command, coordinate and control air operations within an assigned sector or to coordinate air operations with other services. (FMFM 5-60).

MWCS

To be determined.

Mission

The mission that has been assigned or implied by higher headquarters or inferred by the ACE commander.

Mission (AAW)

To be determined.

Mission (ACE Objectives)

To be determined.

Mission (End State)

To be determined.

Mission (JTF -AAW)

To be determined.

Mission (Legal & Political Bounds)

To be determined.

Mission (MAGTF Objectives)

To be determined.

Mission (Possible AAW)

To be determined.

Mission Ready COAs

To be determined.

Mobility

The TAOC has the ability to task organize its assets to support various missions. This ability, combined with the mobility and flexibility afforded by the TAOM and the TAOC's radars allow the TAOC to rapidly respond to myriad of missions.

Passive defense also includes such measures as deception, camouflage and concealment, hardening, EW, mobility, dispersal, redundancy, recovery, and reconstitution. Passive defense is the responsibility of unit commanders at all echelons.

M-1022A1 Mobilizer. In an effort to alleviate mobility problems associated with the TAOC, actions are underway to procure the M-1022A1 for the MACS. The M-1022A1 consists of a pair of dollies which are bolted to the ends of the TAOM shelter, thus allowing the TAOM to be towed behind a 5 ton vehicle. Designed to operate on improved surfaces (i.e., paved or gravel roads), the mobilizer incorporates a hydraulic lift system capable of

lifting the TAOM 10 - 18 inches off the deck. The mobilizer can also be used to facilitate TAOM loading/off loading from aircraft and shipping. Each MACS will receive five M-1022A1 mobilizers.

NCA

The National Command Authority.

Naval Assets (Amphibious)

To be determined.

Non-Engagement Quality Target Info

Targeting information that is below the threshold for the AOOW weapon launch platform to launch the weapon and have it hit the target, requiring additional resolution through ACE, JTF or national assets.

NWP-32

To be determined.

Order (OPORD)

Order identifying the commander's operational concept and intent.

OPORD (ACE - Annex K - Voice)

To be determined.

Orders (Ord)

This category involves directives to take action. It does not include information concerning what the commander intends to do in the future but may tell the recipient what the commander requires to be done in the future. For weapons systems, it may include instructions such as fire, cease-fire, track, drop-track, vector, attack, etc. (Joint Pub 3-56)

Order - Air Tasking Order (ATO)

The ATO is the document that implements tactical air support. It tasks assigned and attached units to accomplish specific missions to support the Joint Force Commander's objectives. The ATO is published daily by the Combat Plans division of the Tactical Air

Control Center and provides sufficient detail to enable mission aircrews and Tactical Air Control System elements to execute assigned missions. (AFM 2-12)

Order (OPlan)

To be determined.

Order (Surveillance -Operating Mode, Readiness State)

To be determined.

Order (Surveillance)

To be determined.

Ordnance

Munitions for assets that will support the AAW mission.

Ordnance (A-A Hawk Standard)

Standard Hawk Anti-Air missile designed to destroy mass raids of aircraft using a stand off fuse and small grain.

Ordnance (Aircraft)

Munitions carried on aircraft that support the AAW mission.

Ordnance (Available)

Available usable munitions for assets that will support the AAW mission.

PC

Wide range of Automated Data Processing equipment with the performance level of a personal computer, below the performance level of a workstation computer.(bottom end of the performance scale).

Physical Implementation

To be determined.

Plans

Plans include all plans to which the ACE Commander is part of. Those plans include the TECH/TAC OPDAT, the Air Defense Plan (ADP), the Joint Air Operations Plan, and higher headquarters Plans.

Plans (CONPLAN)

The concept plan provides the concept of operations.

Plans (AAW)

To be determined.

Plans (ACE Surveillance)

To be determined.

Plans - Airspace Control Plan (ACP)

The document providing specific planning procedures for the airspace control system for a particular area of operation. It is prepared by the Airspace Control Authority.

Plans - Air Defense Plan (ADP)

To be determined.

Plans (EMCON)

Plan that identifies the selective and controlled use of electromagnetic, acoustic, or other emitters to optimize command and control capabilities while minimizing detection by enemy sensors; to minimize mutual interference among friendly systems and/or execute a military deception plan.

Plans (MAGTF OPORD)

To be determined.

Plans (Surveillance /Collection)

To be determined.

Plans (Technical Control Procedures)

To be determined.

Plans (Tech OpDat)

Executing control of radar emissions as outlined in the ACE operation order's emissions control (EMCON) plan, making modification(s) as required by the tactical situation.

Point-to-Point Options

Voice Communications - each TAOM provides internal radio equipment (IRE) to support voice and data communications. Within each TAOM there are four AN/GRC-171A(V)2 or AN/GRC-171A(V)4 ultra-high frequency (UHF) radios, three RT-524 very-high frequency (VHF) radios, and two Harris high frequency (HF) radios. Additional capability exists to introduce externally controlled radios and point-to-point circuitry from outside the TAOC to augment the TAOC's communication requirements. Each TAOM internally houses the required cryptographic instruments to encrypt its radios. Additionally, each TAOM contains one KY-68 secure voice telephone and has the capability to introduce both two and four wire point-to-point telephonic communication devices.

Data Communications. TAOC data link capabilities are listed below.

	POINT TO POINT	TADIL A	TADIL C	REMOTE RADAR
1 TAOM	11 TOTAL	1	1	2
2 TAOM	22 TOTAL	1	1	4
3+ TAOMs	24 TOTAL	1	1	4

Position Request

To be determined.

Positions of Weapons, Surveillance, and C2

To be determined.

Possible Air Control Facility Locations

To be determined.

Possible Air Defense Control Measures

Recommending air defense control measures including WEZs and return-to-force (RTF) procedures for inclusion in the MAGTF operations order.

Airspace Control Order - an order implementing the airspace control plan that provides the details of the approved requests for airspace control measures. It is published as part of the air tasking order or as a separate document. (Joint Pub 1-02) Also called ACO.

Possible Airspace Control Measures

To be determined.

Possible Command Facility Locations

To be determined.

Possible Fire Support Coordination Measures

To be determined.

Possible Sensor Locations & Surveillance Standards

To be determined.

Possible Weapon Locations

Activities related to the coordinating the circumstances and limitations under which forces will initiate and/or continue combat engagement with other forces encountered. ROE allows the commander to exercise control over aviation units and aircraft by prescribing the exact conditions under which they may engage a target. The ROE tells aviation units what they can attack, where they can attack, and when they can attack. ROE will contain at a minimum: The right to self defense, target identification criteria, and weapons control statuses. (FMFM 5-60)

Radio Options

To be determined.

Reattack

To be determined.

Reload Requirement

To be determined.

Reports (Combat Assessment)

Combat Assessment Report - a voice or hard copy message report from the ACE commander to the MAGTF commander. This is a prearranged communication that provides specific information on the activities related to the determination of the overall effectiveness of force employment during military operations. Combat assessment is composed of three major components, (a) battle damage assessment, (b) munitions effects assessment, and (c) reattack recommendations. The objective of combat assessment is to identify recommendations for the course of military operations. (Joint Pub)

Report - Electronic Warfare Support Measures Report (ESM)

The Tactical ESM Report is designed to provide a brief, concise report on time-sensitive electronic emissions of tactical significance and/or of a perishable nature requiring immediate operational consideration. The report is prepared as rapidly as possible after aircraft landing by the collection unit. It is a message report, and its precedence is determined by the request priority and the significance of the information obtained. Those units that normally submit formatted reports in accordance with Standard ELINT Data Systems Codes and Formats under the provisions of the National ELINT Plan will continue to do so unless otherwise directed by proper authority. (JP 3-56.1)

Report (Intelligence)

Intelligence Summary - the INTSUM provides a summary of the intelligence situation covering a specific period of time specified by the joint force commander (usually 6 hours). Normally, the report will be prepared at battalion, wing, task group, and higher echelon. The format for the INTSUM is contained in Appendix L. The report will be prepared in message form and transmitted by appropriate means as determined by its urgency and content. Minimum dissemination will be the next higher, lower, and lateral echelon. Wider distribution will be as directed.

Report (Status)

Prearranged communications that provides specific information on unit(s) status and readiness.

Report (Non-Compliance)

Prearranged communications that provide specific information on a unit's inability to comply with a given order.

Report (Situation)

Prearranged communications that provide specific information on the current tactical situation.

Report - Mission Report (MISREP)

The MISREP is used by all air units (e.g., strike/attack, reconnaissance/surveillance, airlift, observation, and helicopter) to report the results of all missions and significant sightings along the route of the flight. The MISREP amplifies the In-flight Report and is normally submitted within 30 minutes after aircraft landing to the tasking agency, the requesting unit/agency, and to other interested organizations. The MISREP format is outlined in Appendix H. JP 3-56.1)

Report (Tactical-CST)

Tactical Report - a single event of detectable battlefield phenomenon.

Report (Tactical Warning)

A warning after initiation of a threatening or hostile act base upon the evaluation of information from all available sources. In satellite and missile surveillance, a notification to operational command centers that a specific event is occurring. The component elements that describes threat events are: Country Of Origin-- country or countries initiating hostilities; Event Type and Size -- identification of the type of event and determination of the size or number of weapons; Country under Attack-- determined by observing trajectory of an object and predicting its impact point.; Event Time-- time the hostile event occurred. Tactical Warning triggers Passive Defense actions. (Joint Pub 3-01.5)

Request (Intelligence - Theater)

INTEL Request - a hard copy message sent by the ACE commander to the appropriate level of authority requesting information relative to specific anti-air warfare mission including Theater Missile Defense information.

Request for Support (RS)

A voice or a hard copy message report from the ACE commander to the MAGTF commander. This is a prearranged communication through which the ACE commander requests for logistic support such as fuel, ordinance, and missiles.

This category is a part of the circular process of allocating and reallocating support resources. The activity requiring support expresses that requirement with this category of information. Request for support does NOT include the information transmitted to the supporting unit by the supported unit calling for execution of the support previously allocated by the common commander. Requests for support may travel upward or laterally. (Joint Pub 3-56)

Tactical Picture

The display of the link data augmented with reports which provides situation awareness.

Tactical Report

A single event of detectable battlefield phenomenon.

Tactical Report (Theater)

A single event of detectable battlefield phenomenon provided by assets other than ACE-organic.

Tactical Report (ACE)

A single event of detectable battlefield phenomenon detected by ACE-organic assets (A.0.3.1.2)

Tactical Reports

Multiple instances of tactical report entities up to and including the totality of tactical reports in the situational data base and retrievals therefrom, specifically supporting the fusion process.

Tactical Report (CST)

The result of translating the tactical report's original spatial/temporal reference to a common spatial/temporal reference to facilitate the fusion, association and tracking process.

Tactical Report (Launch/Impact Point)

Obtaining the Launch and Impact Points is necessary to determine engage ability by Hawk, THAAD, AEGIS, etc., for maximum Pk.

When connected to the ADCP, three TBM messages are passed:

Ballistic missile message:	State vector and other descriptive data; covariance data.
Reference point message:	Launch point and impact point data.
Data update request message:	Multiple missile update capability

Tactical Report (Visual)

A single event of detectable battlefield phenomenon observed by visual means, valuable in conducting offensive AAW (OAAW).

Tactical Air Command Center (TACC)

In the air defense environment, the TACC may be generally described as a performance supervisor. Under the cognizance of the aviation element G/S.3, AAW aircraft requirements are included within overall aircraft scheduling, offensive AAW is initiated by the aviation element G/S-3 in accordance with information received from intelligence sources. The primary AAW concern of the TACC is to ensure the assignment of interceptor aircraft to the preplanned interceptor requirements, ground alert, or airborne. These aircraft are integrated into the total fixed-wing schedule and the TACC monitors the execution of the daily fragmentary order. In addition to supervising decentralized air defense execution, the TACC possesses divert, sector salvo, and scramble authority.

Tactical Air Operations Center (TAOC)

The TAOC is the agency responsible for requesting, receiving, and coordinating the various identification inputs, maintaining the appropriate aircraft classifications, and responding to queries made by defensive weapons systems by back-tell. As the focus of the sector air defense system, it must anticipate specific input requirements from associated air control elements and recommend appropriate tasking. It is further responsible to anticipate and recommend alternate procedures to preserve air defense continuity should its systems become degraded or inoperative.

TAOC (AN/TPS-59)

A long range (300nm for aircraft, 400nm for TBM) radar that provides a three dimensional picture of the battle space.

TAOC (AN/TPS-59 Operating Mode)

When modified, the radar will be able to operate in three separate modes: Air Breathing Target(ABT), Theater Ballistic Missile(TBM), or Combined. This is important since the radar cannot see TBMs when operating in the ABT mode.

TAOC (AIC)

Air Intercept Controller Responsible for the control of AAW missions from the point the aircraft is handed off from and returned to the traffic section.

TAOC - Missile Coordinator (MC)

Responsible for the control of applicable SAW engagements within the TAOC's area of responsibility.

TAOC (SAAWC)

Sector Anti-air Warfare Coordinator: the SAAWC is the ACE commander's air defense battle manager.

TAOC - Senior Air Director (SAD)

Responsible for the detailed operation of the TAOC.

TAOC - Surveillance Identification Director (SID)

Responsible to the SAD for the detection, identification, and classification of all radar inputs within the TAOC's assigned sector.

TAOC - Senior Traffic Director (STD)

Responsible for the coordination and routing of all air operations within the assigned sector.

TAOC -Senior Weapons Director (SWD)

Responsible for the proper employment of air defense weapons.

TAOC (TDC)

Responsible to the SID for track coordination between the TAOC and other tactical data systems.

Target Identification

The ability to identify an airborne or ground target can limit air operations. Use of visual means, maps, aerial imagery, aircraft and ground sensors and systems (FLIR, NVGs, laser), and good target descriptions increases target identification ability. (FMFM 5-60) For TM Attack operations it is estimated that the target resolution for aircraft would have to be within 1000 M2 in desert climate, 200 M2 in mountains and at least 100 M2 in all cases for artillery. (Meeting with MAWTS-1, 18-19 May 1994)

Target Information

Tactical Air Direction (TAD) Net(s) - TAD nets provide a means for the direction of aircraft in the conduct of offensive air support missions and for the DASC to brief support aircraft on target information or assignment. Normally a VHF or UHF net, TAD nets are also monitored by terminal air controllers (e.g., forward air controller [airborne] [FAC(A)], tactical air coordinator [airborne] [TAC(A)], tactical air control party [TACP]).

127340 M MAW ASRT (ACE) N NONE FLT LDR (N) ()

TG (Terrain/Geography/Oceanographic/Hydrographic Information)

This category of information pertains to all aspects of the environment (other than weather). It includes the configuration, composition, fauna, flora, cultural features, and hydrologic and geophysical characteristics of the land and all aspects of the sea. It includes navigational information, fallout, effects of chemical weapons, and induced radiation data. (Joint Pub 3-56)

Theater Assets (RSTA)

Non Organic Assets are the National Theater Assets assigned to the ACE. Those assets may be weapon systems, or assets to support Reconnaissance, Surveillance and Tactical Assessment (RSTA) missions.

Theater Reconnaissance

Assets such as Cobra Ball, Rivet Joint, U-2, and RF-4.

Threat Capabilities

This category provides the recipient with intelligence on what the enemy can do (if he chooses). It is a basic ingredient of many decisions and weighs heavily on the selection of options. It does not involve the present status of the enemy but deals with possible future actions of the enemy.

Threat Capabilities (EW, TBM, ARM)

Threat Capability - this category provides the recipient with intelligence on what the enemy can do (if he chooses). It is a basic ingredient of many decisions and weighs heavily on the selection of options. It does not involve the present status of the enemy but deals with possible future actions of the enemy. (JCS Pub 3-56) Threat Capabilities Electronic Warfare (EW) - Threat EW Capabilities, Threat Electronic Warfare Support(ES) and Electronic Attack (EA) capabilities. (MACCS Tactical Planning Guide) Threat Capabilities Reconnaissance (Recon)- Threat Reconnaissance Capabilities Determination of the threat's Airborne and Ground reconnaissance capability. (MACCS Tactical Planning Guide).

Threat Capabilities (Reconnaissance)

Determination of the threat's Airborne and Ground reconnaissance capability. (MACCS Tactical Planning Guide)

Terrorist/Unconventional Activities

Determination of potential terrorist or unconventional operations capability. A terrorist with a well-aimed sniper round or a well placed satchel charge can just as easily disrupt the MAGTF's ability to effect the control of aircraft and missiles as can an aircraft with ordinance. (MACCS Tactical Planning Guide)

Time

The available time prior to action occurring or a situation becoming more complex. Time includes response time set by dependent values such as weapon capability, force location and target range.

Track

A number of associated Tactical Reports that have been correlated and associated to provide a history.

Track (Theater)

A number of associated Tactical Reports that have been correlated and associated by non-ACE assets to provide a history.

Track (ACE)

A number of associated Tactical Reports that have been correlated and associated by ACE assets to provide a history, typically by the detecting sensor in the process of detecting a target and building a track history.

Tracks

Multiple instances of track entities up to and including the totality of tracks in the situational data base and retrievals therefrom, specifically supporting the fusion process.

Track (ABT)

A number of associated Tactical Reports that have been correlated and associated to provide a history of the Air Breathing Target being tracked, the track information being made available to weapons platform(s) via TADILs or voice nets (ATDL-1 in the case of AN/TPS-59 A/C track data to HAWK) if not acquired first by the weapons platform.

Track (AN/TPS-59)

A number of associated Tactical Reports that have been correlated and associated by the AN/TSP-59 to provide a history, either TBM, ABT or Cruise Missile. The AN/TPS-59 TBM track is passed to HAWK to ADCP via JTIDS for relay to HAWK via IBDL.

Track (CST)

The result of translating the track's original spatial/temporal reference to a common spatial/temporal reference to facilitate the fusion, association and tracking process.

Track (Weighted)

Using Track (CST)s and/or Tactical Report (CST)s as inputs, it is the result of formulating pair-wise association hypotheses to determine a "most likely" association in order to build a TBM or ABT tracking model.

Track (Correlated)

The output of the fusion process to be used to determine raid size, profile, launch and probable impact points.

Track (Defined)

The output of the acquisition/localization process whereby the track is characterized by raid size, profile, launch and probable impact points.

Track (Engagement Quality)

A number of associated Tactical Reports that have been correlated and associated to provide a history containing targeting information within the threshold for the weapon launch platform to launch the weapon and hit the target. Specifically for the HAWK, the AN/TPS-59 provides engagement quality tracks of sufficient resolution necessary for efficient acquisition by the HAWK High Powered Illumination radar.

Track (Friendly)

One of the results of the identification/classification process whereby a defined track's intention and weapons capabilities is determined.

Track (Threat)

One of the results of the identification/classification process whereby a defined track's intention and weapons capabilities is determined.

Track (JTIDS)

JTIDS is used to exchange TBM track data among JTF assets for engagement by THAAD, HAWK, AEGIS, etc.

Track (JTIDS, AN/TPS-59)

A number of associated Tactical Reports that have been correlated and associated by the AN/TSP-59 to provide a history, either TBM, ABT or Cruise Missile. The AN/TPS-59 TBM track is passed to HAWK to ADCP via JTIDS for relay to HAWK via IBDL. JTIDS is used to exchange TBM track data among JTF assets for engagement by THAAD, HAWK, AEGIS, etc.

Track (Probable ABT)

Results from the comparison of the Track (Defined) entity with the structural and/or behavioral model class when the degree of association exceeds the "Probable ABT" threshold.

Track (Probable TBM)

Results from the comparison of the Track (Defined) entity with the structural and/or behavioral model class when the degree of association exceeds the "Probable TBM" threshold.

Track (Medium Confidence ABT)

Results from the comparison of the Track (Defined) entity with the structural and behavioral model class when the degree of association exceeds the "Medium Confidence ABT" threshold.

Track (Medium Confidence TBM)

Results from the comparison of the Track (Defined) entity with the structural and behavioral model class when the degree of association exceeds the "Medium Confidence TBM" threshold.

Track (Uncorrelated)

Results from the comparison of the Track (Defined) entity with the structural and behavioral model classes when the degree of association fails to exceed either the "Probable ABT" or the "Probable TBM" threshold.

Track (Threat Composition)

The result of the determination of the probability that this Track (Threat) entity is a member of or associated with a raid.

Track (Monitored)

Friendly aircraft are monitored by air controllers for navigation, safety and engagement of targets. Threat tracks continue to be tracked for the engagement process.

Unengageable Target

A target for which it has been determined that ACE, MAGTF and JTF assets are not appropriate to engage.

Vital Areas

A designated area or installation to be defended by air defense units. (Joint Pub 1-02)

Weather Information (WX)

This is a special category extracted from the TG category because or Its profound importance to military operations. (Joint Pub 3-56)

Weapon Control Status

To be determined.

Weapons Assignment

To be determined.

Weighted Air Control Architecture

To be determined.

APPENDIX E. MATRICES AND ANALYSIS

E.1 MATRIX ANALYSIS OVERVIEW

Fourteen matrices are used to describe the Marine Corps TBMD "As Is" system. The matrices were constructed in a tier-like fashion. The information contained within the matrices goes from general to concise. This was necessary to identify deficiencies at the lowest possible level. Information from one or more general-type matrix provided insight for and aided in the construction of specific-type matrices. Each of the matrices, unto itself, provides additional insight into the interrelationships of TBMD activities, organizations, systems, information, and applications.

In reviewing these matrices, it is important to retain a two-dimensional perspective. The intersection of the X and Y axes are coded to demonstrate the presence or absence of a relationship. If the intersection of X and Y is valid, a code is assigned to identify the correct relationship. If the relationship is false, the intersection is left blank. For example, within the INTELLIGENCE TO EQUIPMENT matrix, there may be a specific type of intelligence not processed by a specified piece of equipment. In reality, the intelligence is processed manually. In this case, one must resist the inclination to add an additional parameter to one of the axes which identifies the communication type that processes the intelligence. There is another matrix that examines the relationship of which communication type processes what intelligence. Adding the organization parameter to the first matrix distorts the two-dimensional perspective and adds unnecessary complexity.

However, in the last four matrices, INTELLIGENCE TO TACC-EQUIPMENT-TAOC, INTELLIGENCE TO TAOC-EQUIPMENT-BCP, EQUIPMENT TO TACC-COMMUNICATION TYPE-TAOC, and EQUIPMENT TO TAOC-COMMUNICATION TYPE-BCP, the relationship to be examined takes on two separate two-dimensional perspectives, respectively. The first two-dimensional perspective examines the relationship between the two activities in terms of information flow. The second two-dimensional perspective examines the relationship between the information flow and the equipment used to pass the intelligence between the two activities. In the two remaining matrices, the first

two-dimensional perspective examines the relationship between the two activities and the equipment they employ for information transfer. The second two-dimensional perspective examines the communication type the equipment emulates.

If a specific relationship does not occur within one matrix, the X or Y axis parameter must not be removed, as in the first example, where a specific piece of intelligence is not processed by a specified piece of equipment. Because of the lack of a relationship within that matrix, it would be easy to remove the intelligence parameter. However, if this were allowed, then the intelligence would not be seen on the INTELLIGENCE TO COMMUNICATION TYPE matrix and a vital relationship that shows which communication type processes the intelligence would be lost.

The best approach to developing and reviewing these matrices is to maintain simplicity and avoid using too many codes within a single matrix. If a relationship exists, a character (R-Receive, P-Process, T-Transmit, D-Display, A-All, X or Y) defined within the matrix, is placed in the intersecting box. If a relationship was false, the intersecting box is left blank.

When reviewing a matrix, confusion can arise concerning the definition or description of a specific parameter. For example, the definition of a specific activity may not be understood. To be consistent, definitions from the activity and data model were used to define and clarify the description of that activity. If a specific parameter was not previously defined within the TBMD study, an applicable policy or procedure that might define the confusing item was used.

Analyzing relationships within a matrix can provide clues to voids or discrepan-cies of activities, systems, information, or equipment. For example, an analysis of one of the matrices revealed that a certain type of intelligence was processed by more than one form of communications type within one activity. This indicates that the need for the individual type of intelligence should be investigated. The matrix alone does not provide the answers to these questions. However, it does signal that further investigation may be warranted. The findings from analysis of the actual matrices are presented in Section E.3.

The following is a detailed description of the fourteen matrices used by the author. It describes each matrix in terms of its X and Y parameters, questions to be considered, and conditions to be evaluated.

E.1.1 C2 FACILITY TO ACTIVITY

This matrix is used to identify which C2 Facility is directly or indirectly related to which activity. If a C2 Facility has a relationship to an activity, an (X) is placed in the intersecting box. If a C2 Facility has no relationship to an activity, the intersecting box is left blank.

This matrix should have a direct correlation to the decomposition diagram. The C2 Facility entries should appear as mechanisms. Because of the large volume of activities created within the TBMD "As Is" model (approximately 116), specific activity addresses were used in lieu of descriptive titles.

In some cases, the C2 Facility may use the inputs, outputs or controls of an activity. In other cases the C2 Facility may be directly or indirectly involved with the creation of the activity. Many C2 Facilities may be involved with the use of individual inputs, outputs or controls of an activity or in the creation of the activity.

If a specific C2 Facility is not directly or indirectly related to the activity through its creation or through the use of its inputs, outputs or controls, then further investigation may be required. Is the activity needed? Does the C2 Facility require the inputs, outputs or controls to conduct its mission?

E.1.2 INTELLIGENCE TO ACTIVITY

This matrix is used to identify which piece of intelligence is directly or indirectly related to which activity. If a piece of intelligence has a relationship to an activity, an (X) is placed in the intersecting box. If a piece of intelligence has no relationship to an activity, the intersecting box is left blank.

This matrix should have a direct correlation to the decomposition diagram. The intelligence entries should appear as inputs or controls. Also, because of the large volume of activities created within the TBMD "As Is" model, specific activity addresses were used in lieu of descriptive titles.

In some cases, intelligence may be directly or indirectly utilized by an activity. In other cases, the input of intelligence may be directly or indirectly associated with the creation of the activity. Also, intelligence, in certain cases, may even function as a controlling factor within a specific activity. Finally, in some instances, more than one piece of intelligence may be inputted to an activity or activities.

If a specific piece of intelligence is not directly or indirectly related to an activity through its creation or through its utilization, then further investigation may be required. Is the activity needed? Is the intelligence appropriate for that activity? Is the intelligence needed? Does the intelligence serve a purpose in carrying out the mission?

E.1.3 EQUIPMENT TO C2 FACILITY

This matrix is used to identify whether a piece of communications equipment is associated with a particular C2 Facility. This matrix is the first complex matrix constructed. Its parameters represent the many possible relationships that may exist between equipment and C2 Facilities. If a piece of equipment is used to receive (R), process (P), display (D), transmit (T) or all (A) of the above by a C2 Facility, the appropriate letter or combination of letters is placed in the intersecting box. If the piece of equipment is not employed by a C2 Facility, the intersecting box is left blank.

This matrix should have a direct correlation to DoD, Marine Corps, and Naval Publications. Also, the matrix should have a direct correlation to the "As Is" architecture.

The primary purpose of this matrix is to identify which C2 Facilities employ which types of equipment and how the C2 Facility uses that equipment. The information contained in this matrix was extremely significant in the construction of all but one of the remaining matrices. It is also the first indicator of the existence of redundancy of system capabilities and redundancy of information flows. Every C2 Facility possessed at least one, and in most cases at least three types of communications equipment. When the same types of equipment are used by numerous C2 Facilities, it suggests possible opportunities to eliminate redundant systems. Other areas identified within the matrix may need further investigation. Examples would be as follows: Does the use of different types of equipment within one C2 Facility

hinder or interfere with the mission of that C2 Facility? Is the existing architecture too complicated?

E.1.4 EQUIPMENT TO COMMUNICATION TYPE

This matrix is used to identify whether a piece of equipment is associated with a particular type of communications. The primary focus of this matrix is the identification of the type of transmission each piece of equipment employs. If a relationship between the piece of equipment and the communication type exists, an (X) is placed in the intersecting box. If no relationship exists, the intersecting box is left empty.

This matrix should have a direct correlation to DoD, Marine Corps, and Naval Publications. Also, the matrix should have a direct correlation to the "As Is" architecture.

The information contained in this matrix was also used in the construction of other matrices. The matrix also provides another indicator of redundancy in system capabilities. Areas of concern, which warrant further investigation are: If three or more pieces of equipment utilize the same communication type, is every piece of equipment necessary? Can the architecture benefit from streamlining the equipment? Will the TBMD mission suffer if only one piece of equipment is used for communication?

E.1.5 COMMUNICATIONS TYPE TO C2 FACILITY

This matrix is used to identify whether or not a communications type is utilized by a C2 Facility. If a communication type is used by a C2 Facility, an (X) is placed in the intersecting box. If the communication type is not employed by a C2 Facility, the intersecting box is left blank. This matrix was constructed using the information provided in matrix E.1.3 and in matrix E.1.4.

The primary purpose of this matrix is to identify what form of communication is used to pass information C2 Facilities within the context of the TBMD mission. The secondary purpose of this matrix is to identify whether or not information flow to C2 Facilities is in a usable format. This becomes apparent when reviewing the different communications types for the same C2 Facility. This matrix clearly demonstrates the complexity that exists within and between the C2 Facilities.

In almost every case the C2 Facility has at least two communication types at its disposal. This is an indication of redundancy with the existing systems and brings to light areas that need further investigation. Does each C2 Facility need two or three different communication types? Are two or more communications types being used for the same purpose? Does a need exist for four separate communication types? Can a C2 Facility benefit from the use of a single communications type?

E.1.6 INTELLIGENCE TO C2 FACILITY

This matrix is used to identify what intelligence information is directly or indirectly utilized by which C2 Facility. This matrix is complex because it presents the many possible relationships that may exist between intelligence and C2 Facilities. If a piece of intelligence is received (R), processed (P), displayed (D), transmitted (T) or all (A) of the above by a C2 Facility, the appropriate letter or combination of letters is placed in the intersecting box. If the piece of equipment is not employed by a C2 Facility, the intersecting box is left blank.

In some cases, intelligence may be received, transmitted, processed, or displayed by a C2 Facility. On the other hand, intelligence may be used in any combination of those four. Also, the possibility of more than one piece of intelligence being inputted to more than one C2 Facility is highly probable.

This matrix should have a direct correlation to the decomposition diagram. The intelligence entries should appear as inputs or controls and the C2 Facilities should appear as mechanisms. This matrix was constructed using information contained in matrix E.1.1, matrix E.1.2, and matrix E.1.3.

The primary purpose of this matrix is to try and determine if the correct C2 Facilities are getting the necessary intelligence needed to conduct the mission. For example, what form of intelligence does the JFC (Political ADVISOR) need to carry out his or her mission? Since the JFC (Political Advisor) is only, in fact, an advisor the only forms of intelligence he or she needs is general intelligence (to include the INTREP and the INTSUM) and Threat Capabilities.

If a C2 Facility is not receiving, processing, displaying or transmitting intelligence, or if a C2 Facility is receiving an abundance of intelligence, then further investigation may

be necessary. Does the C2 Facility need that piece of intelligence to carry out its mission? Is the piece of intelligence necessary for TBMD to be accomplished? Can a piece of intelligence be eliminated or combined with other intelligence to fit the needs of a C2 Facility?

E.1.7 INTELLIGENCE TO EQUIPMENT

This matrix is used to identify whether intelligence transmission is associated with a particular piece of equipment. This matrix is complex because it presents many possible relationships between intelligence and equipment. If intelligence is received (R), processed (P), displayed (D), transmitted (T) or all (A) of the above by a piece of equipment, the appropriate letter or combination of letters is placed in the intersecting box. If the piece of equipment is not associated with a piece of equipment, the intersecting box is left blank.

In some cases, intelligence may be received, transmitted, processed, or displayed by a piece of equipment. In other cases, intelligence may be associated, through a combination of those four, with a piece of equipment. Finally, in some instances, more than one type of intelligence may be associated with more than one piece of equipment.

This matrix was constructed using information contained in matrix E.1.3 and matrix E.1.6. The primary purpose of this matrix is to determine which types of intelligence are associated with which piece(s) of equipment. Furthermore the matrix examines what that association is. For example: Is the INTSUM associated with the AN/TPS-59 and what is the manner of that association? The relationship does exist. The INTSUM is received, displayed and transmitted by the AN/TPS-59. The second purpose for the matrix is to determine whether or not a type of intelligence is associated with too many pieces of equipment and visa-versa. For example: Is it really necessary for Threat Capabilities to be received, processed, displayed and transmitted by eight pieces of equipment?

The information contained in this matrix is a definite indication of repetition of equipment capabilities. The matrix also illustrates the necessity to investigate further.

E.1.8 INTELLIGENCE TO COMMUNICATION TYPE

This matrix is used to identify what intelligence information is associated with what communication type. This matrix is semi-complex because it presents two possible

relationships that may exist between intelligence and communication type. A type of intelligence is either received (R) or transmitted (T) by the communication type. If a relationship exists, the appropriate letter or combination of letters is placed in the intersecting box. If the type of equipment is not associated with a communication type, the intersecting box is left blank.

In some cases, intelligence may be received or transmitted by the communication type. In other cases, intelligence may be associated through a combination of both. In no case, however, will there be no association.

This matrix was constructed using information contained in matrix E.1.3, matrix E.1.4, and matrix E.1.7. The primary purpose of this matrix is to determine which type of intelligence is associated with what type of communication process. For example: Is the INTSUM associated with radio communications? If so, what is the manner of that association? There is a relationship and the radio is used to receive and transmit the INTSUM. A second purpose of the matrix is to determine whether or not it is necessary for a type of intelligence to be associated with multiple types of communication. For example, is it really necessary for Threat Capabilities to be received and transmitted by four different communications types?

Again, the information contained in this matrix is an indication of the repetition of communications type capabilities. The matrix also demonstrates a necessity to investigate further.

E.1.9 OUTPUTS TO C2 FACILITY

This matrix is used to identify which outputs are directly or indirectly utilized by which C2 Facility. Also, this matrix is used to identify general information flow within the C2 Facilities. The matrix is complex because it presents the many possible relationships that may exist between outputs and C2 Facilities. If an output is used by a C2 Facility, the output is received (R), processed (P), displayed (D), transmitted (T) or all (A) of the above. If the relationship exists, the appropriate letter or combination of letters is placed in the intersecting box. If the relationship between outputs and C2 Facility does not exist, the intersecting box is left blank.

This matrix should have a direct correlation to the decomposition diagram. The outputs can be in the form of inputs or controls to an activity. The C2 Facility entries should appear as mechanisms. This matrix also was constructed using information contained in matrix E.1.1 and in matrix E.1.3.

The primary purpose of this matrix is to provide insight into the information flows within C2 Facilities. It gives a broad view of what information is used and how that information is passed within the TBMD architecture. The second purpose of the matrix is to provide initial guidance for further analysis of information flow. The information contained in this matrix was used in the construction of other, more specific matrices.

This matrix gives way to questions that can only be answered by more in-depth analysis. Does the information, passed between the C2 Facilities, arrive in a standard format? Is the information, when received, correlated? Is the necessary information getting to the correct C2 Facilities? Is the information received in a timely manner? Is there a need for streamlining the existing architecture?

E.1.10 OUTPUTS TO EQUIPMENT

This matrix is used to identify which outputs are communicated through which types of equipment. Also, this matrix is used to identify the role of equipment in the flow of information. The matrix is complex because it presents the many possible relationships that may exist between outputs and equipment. If an output is communicated through a type of equipment, the output is received (R), processed (P), displayed (D), transmitted (T) or all (A) of the above. If the relationship exists, the appropriate letter or combination of letters is placed in the intersecting box. If the relationship between outputs and equipment does not exist, the intersecting box is left blank.

This matrix should have a direct correlation to the decomposition diagram. The outputs can be in the form of inputs or controls to an activity. Also, this matrix should have a direct correlation to the "As Is" architecture. The equipment types are identified within the architecture. This matrix was constructed using information contained within matrix E.1.3 and matrix E.1.9.

The purpose of this matrix is to provide insight into type of equipment used to communicate information within the TBMD architecture. It provides a perspective on the continued theory of redundancy within the communications framework. Another purpose of the matrix is to provide initial guidance for further analysis of information flow. The information contained in this matrix was used in the construction of other, more specific matrices.

This matrix also leads to questions that can only be answered by further analysis. More specifically, are there too many different types of equipment and types of communication? Does the existence of the numerous communications systems hinder the operations within the TBMD community? Do the equipment types communicate data in a usable format?

E.1.11 EQUIPMENT TO TACC-COMMUNICATION TYPE-TAOC

This matrix is used to demonstrate two separate two-dimensional relationships. First, this matrix examines the relationship between information flow from the TACC to the TAOC. This is accomplished by examining the types of equipment used by the two facilities to pass information. Either one of two relationships exists. The TACC either transmits (T) or receives (R) information using the type of equipment or the TAOC receives or transmits information with the type of equipment. If the relationship exists, the appropriate letter or combination of letters is placed in the intersecting box. If the relationship does not exist, the intersecting box is left blank.

Second, the matrix is used to examine how the information is passed between the two facilities. Once the relationship between the equipment and the C2 Facilities is established, then the relationship between the equipment and communication type can be examined. If there is a relationship between equipment and communication type, an (X) is placed in the intersecting box. If no relationship exists, the intersecting box is left blank.

This matrix was constructed using information contained in matrix E.1.3, matrix E.1.4, and matrix E.1.5. The primary purpose of this matrix is to examine the information flow between the TACC and the TAOC, the type of equipment used to transfer the information from one facility to another, and the type of communications used by the

particular type of equipment. The main focus is on how information is passed and in what format is it passed.

For example, both the TACC and the TAOC used the AN/TPS-59 to receive and transmit information. The communication type is point-to-point. On the other hand, the TACC and TAOC also use a LAN/WAN to receive and transmit information. In this instance the communication type is both radio and land-line. The question now becomes, which type of equipment, combined with the communication type, provides the best format for receiving and transmitting data? To answer this question, further research may be required.

E.1.12 EQUIPMENT TO TAOC-COMMUNICATION TYPE-BCP

This matrix is used to demonstrate two separate two-dimensional relationships. First, this matrix examines the information flow from the TAOC to the BCP. This is accomplished by examining the types of equipment used by the two facilities to pass information. Either one of two relationships exists. The TAOC either transmits (T) or receives (R) information using the type of equipment or the BCP receives or transmits information with the type of equipment. If the relationship exists, the appropriate letter or combination of letters is placed in the intersecting box. If the relationship does not exist, the intersecting box is left blank.

Second, the matrix is used to examine the relationship between how the information is passed between the two facilities. Once a relationship between equipment and the C2 Facilities is established, then the relationship between the equipment and communication type can be examined. If there is a relationship between equipment and communication type, an (X) is placed in the intersecting box. If no relationships exist, the intersecting box is left blank.

This matrix was constructed using information contained in matrix E.1.3, matrix E.1.4, and matrix E.1.5. The primary purpose of this matrix is to examine the information flow between the TAOC and the BCP , the type of equipment used to transfer the information from one facility to another, and the type of communications used by the

particular type of equipment. The main focus is on how information is passed and in what format is it passed.

For example, both the TAOC and the BCP used the ATDL-1, LAN/WAN, and Tactical Radio to receive and transmit data. This is a clear instance of redundancy of system capabilities. Are three different pieces of equipment necessary to perform the same task? Another example is the PAR and CWAR located in the BCP. Both pieces of equipment receive and transmit data. However, the TAOC does not receive or transmit this data. Again, are there too many systems located within these facilities? The answer to these questions may lie with further research.

E.1.13 INTELLIGENCE TO TACC-EQUIPMENT-TAOC

This matrix is used to demonstrate two separate two-dimensional relationships. First, this matrix examines the intelligence flow between the TACC and the TAOC. This is accomplished by examining the types of intelligence used by the two facilities both separately and combined. Either one of two relationships exists. The TACC either transmits (T) or receives (R) intelligence or the TAOC receives or transmits intelligence. If the relationship exists, the appropriate letter or combination of letters is placed in the intersecting box. If the relationship does not exist, the intersecting box is left blank.

Second, the matrix is used to examine the relationship between intelligence and the type of equipment used to pass the intelligence between the two facilities. The matrix also examines the type of equipment available at either facility. Once the relationship between the intelligence and the two facilities is established, then the relationship between the intelligence, the equipment type, and the facility can be examined. If there is a relationship between intelligence and equipment type, an (X) is placed in the intersecting box if the equipment is located within the TACC or a (Y) is placed in the intersecting box if the equipment is located within the TAOC. There is also a possibility that the equipment is located at both facilities. If this is true, a combination of the two letters will be placed in the intersecting box. If no relationship exists, the intersecting box is left blank.

This matrix was constructed using information contained in matrix E.1.3, matrix E.1.6, and matrix E.1.7. The primary purpose of this matrix is to examine the flow of

intelligence between the TACC and the TAOC and the type of equipment used to transfer intelligence from one facility to another. The main focus is on what type of equipment is used to pass the intelligence and the efficiency of the system as a whole.

For example, both the TACC and the TAOC receive and transmit the Report (Tactical Warning). In this instance, both the TAOC and the BCP also possess the same equipment to receive and transmit this piece of intelligence. However, in the case of the INTSUM, while both the TAOC and the BCP receive and transmit the intelligence, they share only one piece of common equipment, the LAN/WAN. This clearly demonstrates the need for the LAN/WAN. However, if the LAN/WAN is used to communicate the Report (Tactical Warning) also, is it necessary to have the other types of equipment at both facilities? This and other questions concerning system redundancy can be better answered with further research.

E.1.14 INTELLIGENCE TO TAOC-EQUIPMENT-BCP

This matrix is used to demonstrate two separate two-dimensional relationships. First, this matrix examines the intelligence flow between the TAOC and the BCP. This is accomplished by examining the types of intelligence used by the two facilities both separately and combined. Either one of two relationships exists. The TAOC either transmits (T) or receives (R) intelligence or the BCP receives or transmits intelligence. If the relationship exists, the appropriate letter or combination of letters is placed in the intersecting box. If the relationship does not exist, the intersecting box is left blank.

Second, the matrix is used to examine the relationship between intelligence and the type of equipment used to pass the intelligence to or from either of the two facilities. This matrix also examines the type of equipment available at either facility. Once the relationship between the intelligence and the two facilities is established, then the relationship between the intelligence, the equipment type, and the facility can be examined. If there is a relationship between intelligence and equipment type, an (X) is placed in the intersecting box if the equipment is located within the TAOC or a (Y) is placed in the intersecting box if the equipment is located within the BCP. There is also a possibility that the equipment is

located at both facilities. If this is true, a combination of the two letters will be placed in the intersecting box. If no relationship exists, the intersecting box is left blank.

This matrix was constructed using information contained in matrix E.1.3, matrix E.1.6, and matrix E.1.7. The primary purpose of this matrix is to examine the flow of intelligence between the TAOC and the BCP and the type of equipment used to communicate the intelligence from one facility to another. The main focus is on what type of equipment is used to pass the intelligence and the efficiency of the system, as a whole.

For example, both the TAOC and the BCP receive and transmit the Report (Combat Assessment). In this instance, both the TAOC and the BCP also possess the same equipment to receive and transmit this piece of intelligence. However, in the case of the INTSUM, the TAOC only transmits this type of intelligence and the BCP only receives this type of intelligence. The equipment used by each C2 Facility varies. Besides the LAN/WAN, Tactical Modem, and Tactical Radio, the TAOC also utilizes the TADIL A and TADIL B. Again, this may be an indication of too many different systems within the facilities.

E.2 TBMD "AS IS" MATRICES

The Marine Corps TBMD matrices are presented below:

C2 Facility vs. Activity

C2 Facility \ Activity	A.0	A.0.1	A.0.1.1	A.0.1.2	A.0.1.2.1	A.0.1.2.2	A.0.1.2.3	A.0.1.2.4	A.0.1.3	A.0.1.3.1	A.0.1.3.2	A.0.1.3.3	A.0.1.4	A.0.1.4.1	A.0.1.4.1.1	A.0.1.4.1.2	A.0.1.4.1.3	A.0.1.4.1.4	A.0.1.4.1.4.1	A.0.1.4.1.4.2	A.0.1.4.1.4.3	A.0.1.4.1.4.4	A.0.1.4.1.4.5	A.0.1.4.1.5	A.0.1.4.1.6	A.0.1.4.2	A.0.1.4.2.1
GCE(FSCC)	X																										
GCE(FAC)	X																										
BCP	X																										
TAOC(Crew)	X																										
TAOC(SID)	X	X											X	X	X	X	X	X	X	X	X	X	X	X	X	X	
TAOC(SWD)	X																										
TAOC(SAAWC)	X	X		X			X		X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	
TAOC(TDC)	X	X											X	X	X	X	X	X	X	X	X	X	X	X	X	X	
JFC(Political Advisor)	X	X		X	X																						
Commander(CAP)	X																										
TACC(ICO)	X																										
HAWK(ADCP)	X																										
HAWK(BCP)	X																										
HAWK(Loader)	X																										
HAWK(TCO)	X																										
ACE Battlestaff(COS)	X																										
ACE Battlestaff(IWO)	X	X	X	X		X	X																				
ACE Battlestaff(FOS)	X	X		X	X				X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X		
ACE Battlestaff(SJA)	X	X		X	X																						
ACE Battlestaff(G-3)	X	X	X	X	X																						
ACE Battlestaff(G-6)	X	X											X													X	X
ACE Battlestaff(FAC)	X																										
ACE Battlestaff(C2WPO)	X	X	X																								
ACE Battlestaff(MWCS)	X	X											X													X	X
ACE Battlestaff(ICO/TDC)	X	X											X													X	
ACE Battlestaff(MACCS(DASC))	X																										
ACE Battlestaff(Frequency Manager)	X	X											X														
ACE Comander	X	X		X				X					X	X	X										X		
Special Forces	X																										
Artillery	X																										
JTF	X																										

Figure E.1

C2 Facility vs. Activity

C2 Facility \ Activity	A.0.1.4.2.1.1	A.0.1.4.2.1.2	A.0.1.4.2.1.3	A.0.1.4.2.1.4	A.0.1.4.2.1.5	A.0.1.4.2.2	A.0.1.4.2.2.1	A.0.1.4.2.2.2	A.0.1.4.2.2.3	A.0.1.4.2.3	A.0.1.4.2.4	A.0.1.4.2.4.1	A.0.1.4.2.4.2	A.0.1.4.2.4.3	A.0.1.4.2.4.4	A.0.1.4.3	A.0.1.4.4	A.0.1.5	A.0.1.5.1	A.0.1.5.2	A.0.1.5.3	A.0.1.5.4	A.0.1.5.5	A.0.1.6	A.0.1.6.1	A.0.1.6.2	A.0.1.6.3
GCE(FSCC)																											
GCE(FAC)																											
BCP																											
TAOC(Crew)						X										X	X										
TAOC(SID)																											
TAOC(SWD)											X			X	X	X	X	X	X	X	X	X	X	X	X	X	
TAOC(SAAWC)						X										X	X										
TAOC(TDC)																											
JFC(Political Advisor)																											
Commander(CAP)																											
TACC(ICO)																											
HAWK(ADCP)																											
HAWK(BCP)																											
HAWK(Loader)																											
HAWK(TCO)																											
ACE Battlestaff(COS)																											
ACE Battlestaff(IWO)											X					X	X	X	X	X	X	X	X	X	X	X	X
ACE Battlestaff(FOS)																											
ACE Battlestaff(SJA)																											
ACE Battlestaff(G-3)		X	X	X		X			X		X	X			X												
ACE Battlestaff(G-6)																											
ACE Battlestaff(FAC)																											
ACE Battlestaff(C2WPO)	X	X	X	X							X				X												
ACE Battlestaff(MWCS)						X	X																				
ACE Battlestaff(ICO/TDC)																											
ACE Battlestaff(MACCS(DASC))											X	X															
ACE Battlestaff(Frequency Manager)																											
ACE Commander																											
Secial Forces																											
Artillery																											
JTF																											

Figure E.1 (Continued)

C2 Facility vs. Activity

C2 Faclity \ Activity	A.0.1.6.4	A.0.1.6.5	A.0.1.7	A.0.2	A.0.3	A.0.3.1	A.0.3.1.1	A.0.3.1.1.1	A.0.3.1.1.2	A.0.3.1.1.3	A.0.3.1.2	A.0.3.1.3	A.0.3.1.3.1	A.0.3.1.3.2	A.0.3.1.3.3	A.0.3.1.3.3.1	A.0.3.1.3.3.2	A.0.3.1.3.3.3	A.0.3.1.3.4	A.0.3.1.4	A.0.3.1.4.1	A.0.3.1.4.2	A.0.3.1.4.3	A.0.3.1.5	A.0.3.2	A.0.3.3	A.0.4
GCE(FSCC)																											
GCE(FAC)																											
BCP																											
TAOC(Crew)																											
TAOC(SID)				X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X			
TAOC(SWD)																											
TAOC(SAAWC)	X	X	X	X	X	X	X	X	X																		X
TAOC(TDC)																											
JFC(Political Advisor)																											
Commander(CAP)																											
TACC(ICO)				X																							
HAWK(ADCP)					X	X						X	X	X	X	X				X		X		X	X	X	
HAWK(BCP)					X	X						X	X	X	X	X				X		X		X	X	X	
HAWK(Loader)																											
HAWK(TCO)																											
ACE Battlestaff(COS)				X																							
ACE Battlestaff(IWO)																											
ACE Battlestaff(FOS)	X	X	X																								X
ACE Battlestaff(SJA)																											
ACE Battlestaff(G-3)																											
ACE Battlestaff(G-6)																											
ACE Battlestaff(FAC)																											
ACE Battlestaff(C2WPO)					X	X	X			X																	
ACE Battlestaff(MWCS)																											
ACE Battlestaff(ICO/TDC)					X	X	X	X	X			X			X	X	X	X		X	X	X	X		X	X	
ACE Battlestaff(MACCS(DASC))																											
ACE Battlestaff(Frequency Manager)																											
ACE Commander																											
Spcial Forces																											
Artillery																											
JTF																											

Figure E.1 (Continued)

C2 Facility vs. Activity

C2 Facility / Activity	A.0.4.1	A.0.4.2	A.0.4.3	A.0.4.4	A.0.4.5	A.0.5	A.0.5.1	A.0.5.2	A.0.5.2.1	A.0.5.2.1.1	A.0.5.2.1.2	A.0.5.2.1.3	A.0.5.2.1.4	A.0.5.2.1.5	A.0.5.2.2	A.0.5.2.2.1	A.0.5.2.2.1.1	A.0.5.2.2.1.2	A.0.5.2.2.1.3	A.0.5.2.2.1.4	A.0.5.2.2.1.5	A.0.5.2.2.1.6	A.0.5.2.2.2	A.0.5.3	A.0.5.3.1	A.0.5.3.2	A.0.5.3.2.1
GCE(FSCC)						X																		X	X	X	X
GCE(FAC)						X	X																	X	X	X	
BCP						X	X																				
TAOC(Crew)						X		X	X	X		X	X		X	X			X								
TAOC(SID)						X	X																				
TAOC(SWD)						X	X	X	X			X	X		X	X		X					X				
TAOC(SAAWC)	X	X	X	X	X	X		X	X			X	X		X	X		X	X				X	X	X	X	X
TAOC(TDC)																											
JFC(Political Advisor)																											
Commander(CAP)						X		X	X			X	X		X								X				
TACC(ICO)																											
HAWK(ADCP)						X		X							X	X	X						X				
HAWK(BCP)						X		X							X								X				
HAWK(Loader)						X		X	X					X	X	X						X	X				
HAWK(TCO)						X		X	X		X	X	X		X	X				X	X						
ACE Battlestaff(COS)						X		X	X		X	X	X		X	X				X	X		X	X		X	X
ACE Battlestaff(IWO)																											
ACE Battlestaff(FOS)	X	X	X	X	X																						
ACE Battlestaff(SJA)																											
ACE Battlestaff(G-3)																											
ACE Battlestaff(G-6)																											
ACE Battlestaff(FAC)																											
ACE Battlestaff(C2WPO)																											
ACE Battlestaff(MWCS)																											
ACE Battlestaff(ICO/TDC)																											
ACE Battlestaff(MACCS(DASC))						X																		X		X	X
ACE Battlestaff(Frequency Manager)																											
ACE Commander					X																						
Special Forces						X																		X			
Artillery						X																		X			
JTF						X																		X			

Figure E.1 (Continued)

C2 Facility vs. Activity

C2 Facility \ Activity	A.0.5.3.2.2	A.0.5.3.2.2.1	A.0.5.3.2.2.2	A.0.5.3.2.2.3	A.0.5.3.2.2.4	A.0.5.3.2.3	A.0.5.3.3	A.0.5.4
GCE(FSCC)	X	X						
GCE(FAC)	X	X						
BCP								
TAOC(Crew)								
TAOC(SID)								
TAOC(SWD)								
TAOC(SAAWC)								
TAOC(TDC)								
JFC(Political Advisor)								
Commander(CAP)								
TACC(ICO)								
HAWK(ADCP)								
HAWK(BCP)								
HAWK(Loader)								
HAWK(TCO)								
ACE Battlestaff(COS)	X	X						
ACE Battlestaff(IWO)								
ACE Battlestaff(FOS)								
ACE Battlestaff(SJA)								
ACE Battlestaff(G-3)								
ACE Battlestaff(G-6)								
ACE Battlestaff(FAC)								
ACE Battlestaff(C2WPO)								
ACE Battlestaff(MWCS)								
ACE Battlestaff(ICO/TDC)								
ACE Battlestaff(MACCS(DASC))	X		X					
ACE Battlestaff(Frequency Manager)								
ACE Commandder								
Special Forces							X	
Artillery							X	
JTF							X	

Figure E.1 (Continued)

Intelligence vs. Activity

Intelligence \ Activity	A.0	A.0.1	A.0.1.1	A.0.1.2	A.0.1.2.1	A.0.1.2.2	A.0.1.2.3	A.0.1.2.4	A.0.1.3	A.0.1.3.1	A.0.1.3.2	A.0.1.3.3	A.0.1.4	A.0.1.4.1	A.0.1.4.1.1	A.0.1.4.1.2	A.0.1.4.1.3	A.0.1.4.1.4	A.0.1.4.1.4.1	A.0.1.4.1.4.2	A.0.1.4.1.4.3	A.0.1.4.1.4.4	A.0.1.4.1.4.5	A.0.1.4.1.5	A.0.1.4.1.6	A.0.1.4.2	A.0.1.4.2.1
INTSUM	X	X	X						X	X	X	X															
TIBS/TRAP Info	X																										
IPBDB Info	X	X	X						X	X																	
Report (ESM)	X																										
Report (Intellgence)	X																										
Report (Situation)	x																										
Report (Status)	X																										
Report (Combat Assessment)	X	X	X																								
Report (Tactical)	X																										
Intelligence	X	X		X	X		X																				
Track (AN/TPS-59 Data)	X	X											X													X	
Tactical Picture	X																										
Theater Capabilities	X	X																									
Threat Capabilities	X	X		X	X		X	X					X	X			X	X	X	X	X	X				X	
Target Identification	X																										
TG	X	X							X	X	X	X	X	X		X	X	X	X					X		X	X
Vital Areas	X	X											X	X			X										
WX	X	X							X	X																	

Figure E.1 (Continued)

Intelligence vs. Activity

Intelligence \ Activity	A.0.1.4.2.1.1	A.0.1.4.2.1.2	A.0.1.4.2.1.3	A.0.1.4.2.1.4	A.0.1.4.2.1.5	A.0.1.4.2.2	A.0.1.4.2.2.1	A.0.1.4.2.2.2	A.0.1.4.2.2.3	A.0.1.4.2.3	A.0.1.4.2.4	A.0.1.4.2.4.1	A.0.1.4.2.4.2	A.0.1.4.2.4.3	A.0.1.4.2.4.4	A.0.1.4.3	A.0.1.4.4	A.0.1.5	A.0.1.5.1	A.0.1.5.2	A.0.1.5.3	A.0.1.5.4	A.0.1.5.5	A.0.1.6	A.0.1.6.1	A.0.1.6.2	A.0.1.6.3
INTSUM																											
TIBS/TRAP Info																											
IPBDB Info																											
Report (ESM)																											
Report (Intelligence)																											
Report (Situation)																											
Report (Status)																											
Report (Combat Assessment)																											
Report (Tactical)																											
Intelligence																		X	X						X	X	
Track (AN/TPS-59 Data)						X	X	X																			
Tactical Picture																											
Theater Capabitilies																		X	X		X						
Threat Capabilities											X			X		X											
Target Identification																		X		X							
TG		X	X	X	X											X											
Vital Areas																X		X	X								
WX																											

Figure E.1 (Continued)

Intelligence vs. Activity

Intelligence \ Activity	A.0.1.6.4	A.0.1.6.5	A.0.1.7	A.0.2	A.0.3	A.0.3.1	A.0.3.1.1	A.0.3.1.1.1	A.0.3.1.2	A.0.3.1.1.3	A.0.3.1.2	A.0.3.1.3	A.0.3.1.3.1	A.0.3.1.3.2	A.0.3.1.3.3	A.0.3.1.3.3.1	A.0.3.1.3.3.2	A.0.3.1.3.3.3	A.0.3.1.3.4	A.0.3.1.4	A.0.3.1.4.1	A.0.3.1.4.2	A.0.3.1.4.3	A.0.3.1.5	A.0.3.2	A.0.3.3	A.0.4
INTSUM																											X
TIBS/TRAP Info																											
IPBDB Info					X	X													X	X	X						
Report (ESM)																											
Report (Intelligence)																											
Report (Situation)																											
Report (Status)																											X
Report (Combat Assessment)																											
Report (Tactical)					X	X						X	X	X	X	X		X									
Intelligence									X																		X
Track (AN/TPS-59 Data)					X	X	X					X		X	X	X	X	X	X	X		X	X	X	X	X	
Tactical Picture																											X
Theater Capabilities					X	X	X																				
Threat Capabilities					X	X	X	X		X																	
Target Identification																											
TG					X	X	X	X	X																		
Vital Areas																											
WX																											

Figure E.1 (Continued)

Intelligence vs. Activity

Intelligence \ Activity	A.0.4.1	A.0.4.2	A.0.4.3	A.0.4.4	A.0.4.5	A.0.5	A.0.5.1	A.0.5.2	A.0.5.2.1	A.0.5.2.1.1	A.0.5.2.1.2	A.0.5.2.1.3	A.0.5.2.1.4	A.0.5.2.1.5	A.0.5.2.2	A.0.5.2.2.1	A.0.5.2.2.1.1	A.0.5.2.2.1.2	A.0.5.2.2.1.3	A.0.5.2.2.1.4	A.0.5.2.2.1.5	A.0.5.2.2.1.6	A.0.5.2.2.2	A.0.5.3	A.0.5.3.1	A.0.5.3.2	A.0.5.3.2.1
INTSUM			X																								
TIBS/TRAP Info						X		X							X	X	X	X									
IPBDB Info																											
Report (ESM)						X																		X		X	X
Report (Intelligence)						X																		X		X	X
Report (Situation)	X																										
Report (Status)				X																							
Report (Combat Assessment)																											
Report (Tactical)						X		X							X	X	X						X	X		X	
Intelligence	X		X			X		X	X	X	X				X								X				
Track (AN/TPS-59 Data)						X		X	X	X	X	X	X		X	X			X	X							
Tactical Picture		X	X			X		X	X	X	X				X	X	X	X		X	X		X				
Theater Capabilities																											
Threat Capabilities																								X		X	X
Target Identification																											
TG																											
Vital Areas																											
WX																											

Figure E.1 (Continued)

Intelligence vs. Activity

Intelligence \ Activity	A.0.5.3.2.2	A.0.5.3.2.2.1	A.0.5.3.2.2.2	A.0.5.3.2.2.3	A.0.5.3.2.2.4	A.0.5.3.2.3	A.0.5.3.3	A.0.5.4
INTSUM								
TIBS/TRAP Info								
IPBDB Info								
Report (ESM)	X		X			X		
Report (Inelligence)	X		X			X		
Report (Situation)								
Report (Status)								
Report (Combat Assessment)								
Report (Tactical)	X		X			X		
Intelligence								
Track (AN/TPS-59 Data)								X
Tactical Picture								
Theater Capabilities								
Threat Capabilities	X		X			X		
Target Identification								
TG								
Vital Areas								
WX								

Figure E.1 (Continued)

Equipment vs. C2 Facility

R-Receive, D-Display, P-Process, T-Transmit, A-All

Equipment \ C2 Facility	GCE(FSCC)	GCE(FAC)	TAOC(SID)	TAOC(SWD)	TAOC(SAAWC)	TAOC(TDC)	JFC(Political Advisor)	JTF Commander	Commander(CAP)	HAWK (TCO)	ACE Battlestaff(COS)	ACE Battlestaff(IWO)	ACE Battlestaff(FOS)	ACE Battlestaff(SJA)	ACE Battlestaff(G-3)	ACE Battlestaff(G-6)	ACE Battlestaff(C2WPO)	ACE Battlestaff(MWCS)	ACE Battlestaff(ICO/TDC)	ACE Battlestaff(MACCS(DASC))	ACE Battlestaff(Frequency Manager)	ACE Commander	Special Forces	Artillery
AN/TPS-59			A	RD	RD	RD				RDT														
TADIL A			A	RDP	RD	A					DP	D							A			D		
TADIL B			A	RDP	RD	A					DP	D							A			D		
TADIL C				A					A															
ATDL-1			RDT	A	RD	RD				A														
LAN/WAN	RT				A		RT	RT		RPT	RPT		RT	RT	RT	RT	RT	RT	RT	RT	RT	RT		RT
PC	DP				DP		DP	DP					DP	DP	DP	DP	DP	DP	DP	DP	DP	DP		DP
Tactical Modem	RT				RT		RT	RT					RT					RT		RT	RT	RT		RT
PAR										A														
CWAR										A														
Manual	D	D	D	D	D	D	D	D			D	D	D	D	D	D	D	D	D	D		D	D	D
Tactical Radio	RT	RT	RT	RT	RT	RT			RT	RT	RT	RT							RT	RT	RT	RT	RT	RT
TAOM			DP	DP	DP	DP																		
BCP										DP														

Figure E.1 (Continued)

Equipment vs. Communication Type

Equipment	Satellite	Landline	Radio	Point-to-Point
AN/TPS-59			X	
TADIL A				X
TADIL B	X	X	X	
TADIL C			X	
ATDL-1		X	X	
LAN/WAN		X	X	
PC		X	X	
Tactical Modem		X	X	
PAR				X
CWAR				X
Tactical Radio			X	
TAOM		X	X	X
BCP		X	X	X

Figure E.1 (Continued)

Communication Type vs. C2 Facility

Comm Type \ C2 Facility	GCE(FSCC)	GCE(FAC)	TAOC(SID)	TAOC(SWD)	TAOC(SAAWC)	TAOC(TDC)	JFC(Political Advisor)	JTF Commander	Commander(CAP)	HAWK (TCO)	ACE Battlestaff(COS)	ACE Battlestaff(IWO)	ACE Battlestaff(FOS)	ACE Battlestaff(SJA)	ACE Battlestaff(G-3)	ACE Battlestaff(G-6)	ACE Battlestaff(C2WPO)	ACE Battlestaff(MWCS)	ACE Battlestaff(ICO/TDC)	ACE Battlestaff(MACCS(DASC))	ACE Battlestaff(Frequency Manager)	ACE Commander	Special Forces	Artillery
Satellite			X	X	X	X					X	X							X			X		
Landline	X		X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X		X
Radio	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Point-to-Point	X		X	X	X	X	X	X		X			X					X		X	X	X		X

Figure E.1 (Continued)

Intelligence vs. C2 Facility

Receive, T-Transmit, P-Process, D-Display, A-All / C2 Facility	GCE(FSCC)	GCE(FAC)	TAOC(SID)	TAOC(SWD)	TAOC(SAAWC)	TAOC(TDC)	JFC(Political Advisor)	JTF Commander	Commander(CAP)	HAWK(TCO)	ACE Battlestaff(COS)	ACE Battlestaff(IWO)	ACE Battlestaff(FOS)	ACE Battlestaff(SJA)	ACE Battlestaff(G-3)	ACE Battlestaff(G-6)	ACE Battlestaff(C2WPO)	ACE Battlestaff(MWCS)	ACE Battlestaff(ICO/TDC)	ACE Battlestaff(MACCS(DASC))	ACE Battlestaff(Frequency Manager)	ACE Commander	Special Forces	Artillery
Intelligence																								
INTSUM					A						A	A	A		A		A							
TIBS/TRAP Info				A	A				A	A														
IPBDB Info			A		A					A		A	A		A		A		A					
Report (ESM)	A	RDT			A			A	A	A	A									A		A	RDT	A
Report (Intelligence)	A	RDT			A			A	A	A	A									A			RDT	A
Report (Situation)					A								A									A		
Report (Status)					A								A											
Report (Combat Assessment)					A							A			A		A							
Report (Tactical Warning)	A	RDT	A	A	A			A	A	A	A								A	A			RDT	A
Intelligence				A	A		A	A		A	A	A	A	A	A							A		A
Track (AN/TPS-59 Data)			A	A	A	A			A	A	A		A			A			A					
Tactical Picture				A	A				A	A	A		A											
Threat Capabilities	A	RDT	A		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	RDT	A
Target Identification					A								A											
TG			A		A	A				A			A			A		A	A			A		
WX					A								A											

Figure E.1 (Continued)

Intelligence vs. Equipment

R-Receive, T-Transmit, P-Process, D-Display, A-All

Intelligence \ Equipment	AN/TPS-59	TADIL A	TADIL B	TADIL C	ATDL-1	LAN/WAN	PC	Tactical Modem	PAR	CWAR	Manual	Tactical Modem	TAOM	BCP
INTSUM	RD	RDP	RDP		RD	A	DP	RT			D	RT	DP	
TIBS/TRAP Info	RDT	RDP	RDP	A	A	A	DP	RT	A	A	D	RT	DP	DP
IPBDB Info	A	A	A		A	A	DP	RT	A	A	D	RT	PD	
Report (ESM)	RDT	RDP	RDP	A	A	A	DP	RT	A	A	D	RT	DP	DP
Report (Intelligence)	RDT	RDP	RDP	A	A	A	DP	RT	A	A	D	RT	DP	DP
Report (Situation)	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
Report (Status)	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
Report (Combat Assessment)	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
Report (Tactical Warning)	A	A	A	A	A	A	DP	RT	A	A	D	RT	DP	DP
Intelligence	RDT	RDP	RDP	A	A	A	DP	RT	A	A	D	RT	DP	DP
Track (AN/TPS-59 Data)	A	A	A	A	A	A	DP	RT	A	A	D	RT	DP	DP
Tactical Picture	RDT	RDP	RDP	A	A	A	DP	RT	A	A	D	RT	DP	DP
Threat Capabilities	A	A	A	A	A	A	DP	RT	A	A	D	RT	DP	DP
Target Identification	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
TG	A	A	A		A	A	DP	RT	A	A	D	RT	DP	DP
WX	RD	RD	RD		RD	A	DP	RT			D	RT	DP	

Figure E.1 (Continued)

Intelligence vs. Communication Type

R-Receive, T-Transmit

Intelligence	Satellite	Landline	Radio	Point-to-Point
INTSUM	R	RT	RT	R
TIBS/TRAP Info	R	RT	RT	RT
IPBDB Info	RT	RT	RT	RT
Report (ESM)	R	RT	RT	RT
Report (Intelligence)	R	RT	RT	RT
Report (Situation)	R	RT	RT	R
Report (Status)	R	RT	RT	R
Report (Combat Assessment)	R	RT	RT	R
Report (Tactical Warning)	RT	RT	RT	RT
Intelligence	R	RT	RT	RT
Track (AN/TPS-59 Data)	RT	RT	RT	RT
Tactical Picture	R	RT	RT	RT
Threat Capabilities	RT	RT	RT	RT
Target Identification	R	RT	RT	R
TG	RT	RT	RT	RT
WX	R	RT	RT	R

Figure E.1 (Continued)

Outputs vs. C2 Facilities

R-Receive, P-Process, D-Display, T-Transmit, A-All

Outputs / C2 Facility	GCE(FSCC)	GCE(FAC)	TAOC(SID)	TAOC(SWD)	TAOC(SAAWC)	TAOC(TDC)	JFC(Political Advisor)	JTF Commander	Commander(CAP)	HAWK(TCO)	ACE Battlestaff(COS)	ACE Battlestaff(IWO)	ACE Battlestaff(FOS)	ACE Battlestaff(SJA)	ACE Battlestaff(G-3)	ACE Battlestaff(G-6)	ACE Battlestaff(C2WPO)	ACE Battlestaff(MWCS)	ACE Battlestaff(ICO/TDC)	ACE Battlestaff(MACCS(DASC))	ACE Battlestaff(Frequency Manager)	ACE Commander	Special Forces	Artillery
Initial Targeting Info	T	T									T									A				
Engagement Quality Target Info																				T				
Non-Engagement Quality Target Info																				T				
Report(Combat Assessment)	T	T		T	T			T	T	T	T									T			T	T
Asset Availability(ACE-Aircraft)	T	RDP			A						A									A				
Unegageable Target	T	T			T			RDP															RDP	RDP
Weapon Assignment	A	A			A						RDP									RDP				
Request(Support)	T	T			T			T			T												T	T
Launch/Impact Point				RDP	RDP					T														
Information				T	A																			
Track(Engagement Quality)					T					RDP	RDP													
Weapons Assignment				A	A				A	A	A													
Reload Requirement										A	T													
Reattack				A	A				T	A	A													
Target Info				T	T					A	RDP													
ID Threat				RDP	RDP				RDP	A	A													
Ordance(Availability)				T	T				T	A	T													
Command and Control		T	A		A				RDP	RDP	RDP													
Report(Status)				T	T				T	T	T													
Threat Warning																								
Current Mission Objectives					A								A											
COA's					A								A											
Approved Plans					T								T											
ACE Capabilities (Relative Combat Power)					RDP		RDP					A	RDP	RDP	A		T					RDP		
Threat ID					RDP							T	RDP		T		T							
Guidance (ACE Priorities & Intent)			RDP		A	RDP	T					T	A	T	T							T		

Figure E.1 (Continued)

Outputs vs. C2 Facilities

Outputs \ C2 Facility	GCE(FSCC)	GCE(FAC)	TAOC(SID)	TAOC(SWD)	TAOC(SAAWC)	TAOC(TDC)	JFC(Political Advisor)	JTF Commander	Commander(CAP)	HAWK(TCO)	ACE Battlestaff(COS)	ACE Battlestaff(IWO)	ACE Battlestaff(FOS)	ACE Battlestaff(SJA)	ACE Battlestaff(G-3)	ACE Battlestaff(G-6)	ACE Battlestaff(C2WPO)	ACE Battlestaff(MWCS)	ACE Battlestaff(ICO/TDC)	ACE Battlestaff(MACCS(DASC))	ACE Battlestaff(Frequency Manager)	ACE Commander	Special Forces	Artillery
COA and Possible Enemy Response					A								A											
Mission Ready COA's					A								A									RDP		
Selected COA					T								T									T		
Track(Uncorrelated)			A		A					A									A					
Track(Probable TBM)			A		A					A									A					
Track(Probable ABT)			A		A					A									A					
Track(Medium Confidence ABT)			A																A					
Track(Medium Confidence TBM)			A																A					
Possible Command Facilities Location		A		A	A																			
Possible Sensor Locations&Surveillance Std		A		A	A																			
Track(Friendly)			T		T					A									A					
Track(Threat)			A		T					A									T					
Track(CST)			A							T									A					
Report(Tactical-CST)			A							T									A					
Track(Weighted)			A																A					
Report(Tactical Warning)			T		T					T									T					
Track(Correlated)			A																T					
Track(ACE)			A							A														
Possible Weapons Location			A		A	A																		
Report(Tactical)			A							A									A					
Track(Defined)			A		RDP					A									A					
Position Request			A		A														A					
Mission (Legal & Political Bounds)					RDP		T					T	RDP	T	T									
Boundaries (ACE AO)													T											
Boundaries (ACE AOI)													A											
Battlespace													T											

Figure E.1 (Continued)

Outputs vs. C2 Facilities

Outputs / C2 Facility	GCE(FSCC)	GCE(FAC)	TAOC(SID)	TAOC(SWD)	TAOC(SAAWC)	TAOC(TDC)	JFC(Political Advisor)	JTF Commander	Commander(CAP)	HAWK(TCO)	ACE Battlestaff(COS)	ACE Battlestaff(IWO)	ACE Battlestaff(FOS)	ACE Battlestaff(SJA)	ACE Battlestaff(G-3)	ACE Battlestaff(G-6)	ACE Battlestaff(C2WPO)	ACE Battlestaff(MWCS)	ACE Battlestaff(ICO/TDC)	ACE Battlestaff(MACCS(DASC))	ACE Battlestaff(Frequency Manager)	ACE Commander	Special Forces	Artillery
Report(Non-Compliance)			A		A														A					
Request(Intelligence-Theater)			A		A					T									A					
Order(Surveillance)			A		T														T					
Order(Surveillance,Op Mode,Readiness State)			A		T												T		T					
Tactical Report(ACE)			A																RDP					
Track(Threat Composition)			T							A									A					
Track(Monitored)										A									A					
Tactical Picture										T									T					
Plans(AAW)					A								A											
Plans(Air Defense)					A								A											
Plans(ACP)					A								A											
Plans(AAW Portion of ATO)					A								A											
Plans(Surveillance/Collection)					T								T											
Plans			T		T	T							T			T		T	T					
Air Superiority Required					A								A											
Allocation Shortfalls					A								A											
Resolved Shortfalls					A								A											
ROE					T								T											
Request(Allocation)					A								A											
Request(Combat Service Support)					T								T											
Plans(TechOpDat)					RDP																			
Plans(EMCON)					A								A			RDP		RDP						
ACE Assets (Shortfalls)			T		T	T							T			T			T			T		
ACE C3 Architecture (C2 Options)			A		A	A							A									A		
ACE Assets (Shortfall - C2 & Weapons)			T		T	T							T									T		
ACE Assets (Weapons - Sitting Options)			T		T	T																		

Figure E.1 (Continued)

Outputs vs. C2 Facilities

Outputs \ C2 Facility	GCE(FSCC)	GCE(FAC)	TAOC(SID)	TAOC(SWD)	TAOC(SAAWC)	TAOC(TDC)	JFC(Political Advisor)	JTF Commander	Commander(CAP)	HAWK(TCO)	ACE Battlestaff(COS)	ACE Battlestaff(IWO)	ACE Battlestaff(FOS)	ACE Battlestaff(SJA)	ACE Battlestaff(G-3)	ACE Battlestaff(G-6)	ACE Battlestaff(C2WPO)	ACE Battlestaff(MWCS)	ACE Battlestaff(ICO/TDC)	ACE Battlestaff(MACCS(DASC))	ACE Battlestaff(Frequency Manager)	ACE Commander	Special Forces	Artillery
Plans(Technical Control Procedures)					T								T			T		T						
ACE C3 Architecture(Comm Net&Freq Assign)					T								A			T		T			T			
TADIL Interface Options			T		T	T				T						T			T					
Point-to-Point Options										T														
LAN/WAN Options																T								
ACE C3 Architecture(Data Options)			T			T				T						T			T					
OpOrd(AOE-Annex K-Voice)																RDP		A						
Satellite Options																T		T						
Landline Options																T		T						
Radio Options																T		T						
Launch Warning Options																								
ACE C3 Architecture(Voice Options)																T		T						
ACE Assets(Shortfalls-Comm)			T		T	T										T			T					
ACE C3 Architecture(Weighted Comm Options)			T		A	T							RDP			A		RDP	T		RDP			
Possible Air Facilities Location			A		A	A							A											
Possible Fire Support Coordination Measures			A		A	A							A											
Possible Airspace Control Measures			A		A	A							A											
Possible Air Defense Control Measures			A		A	A							A											
Weight Air Control Architecture			A		A	A							T											
Air Control Air Direction Authority			A		A	A							A											
Vital Areas			RDP		RDP	RDP							RDP									T		
Mission (Possible AAW)					T								T									RDP		
Guidance (MAGTF Priorities & Intent)					RDP								A											
Time to Intercept Estimates					T								A											
ACE C3 Architecture			T		T	T										T			T					
ACE C3 Architecture (Casualty Options)			A		A	A							A											

Figure E.1 (Continued)

Outputs vs. Equipment

R-Receive, P-Process, D-Display, T-Transmit, A-All

Outputs \ Equipment	AN/TPS-59	TADIL A	TADIL B	TADIL C	ATDL-1	LAN/WAN	PC	Tactical Modem	PAR	CWAR	Manual	Tactical Radio	TAOM	BCP
Initial Targeting Info						RT	DP	RT			D	T		
Engagement Quality Target Info						T		T						
Non-Engagement Quality Target Info						T		T						
Report(Combat Assessment)	T			T	T	T		T	T	T		T		
Asset Availability(ACE-Aircraft)	RD	RDP	RDP		RD	A	DP	RT			D	RT	DP	
Unegageable Target						RT	DP	RT			D	RT	DP	
Weapon Assignment	RD	RDP	RDP		RD	A	DP	RT			D	RT	DP	
Request(Support)						T		T				T		
Launch/Impact Point	RDT	RDP	RDP	RDP	A	A	DP	R	T	T	D	RT	DP	
Information	RD	RD	RD	T	RDT	A	DP	RT			D	RT	DP	
Track(Engagement Quality)	RD	DP	DP		RDP	RPT		T	RDP	RDP	D	RT	DP	
Weapons Assignment	RDT	RDP	RDP	A	A	A	DP	RT	A	A	D	RT	DP	DP
Reload Requirement	RDT				A	RPT			A	A	D	RT		DP
Reattack	RDT	RDP	RDP	A	A	A	DP	RT	A	A	D	RT	DP	DP
Target Info	RDT	DP	DP	A	A	RPT		T	A	A	D	RT		DP
ID Threat	RDT	RDP	RDP	RDP	A	A	DP	R	A	A	D	RT	DP	DP
Ordance(Availability)	RDT			T	A	RPT		T	A	A		RT		DP
Command and Control	A	A	A		A	A	DP	RT	RDP	RDP	D	RT	DP	DP
Report(Status)	T			T	T	T		T	T	T		T		
Threat Warning														
Current Mission Objectives	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
COA's	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
COAand Possible Enemy Response	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
Mission Ready COA's	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
Selectd COA						T		T				T		
Approved Plans						T		T				T		

Figure E.1 (Continued)

Outputs vs. Equipment

Outputs \ Equipment	AN/TPS-59	TADIL A	TADIL B	TADIL C	ATDL-1	LAN/WAN	PC	Tactical Modem	PAR	CWAR	Manual	Tactical Radio	TAOM	BCP
Vital Areas	RDP	RDP	RDP		RD	RT	DP	RT			D	RT	DP	
Mission (Possible AAW)		D	D			RT	DP	RT			D	RT		
Guidance (MAGTF Priorities & Intent)						RT	DP	RT			D	R	DP	
Track(Uncorrelated)	A	A	A		A	A	DP	RT	A	A	D	RT	DP	DP
Track(Probable TBM)	A	A	A		A	A	DP	RT	A	A	D	RT	DP	DP
Track(Probable ABT)	A	A	A		A	A	DP	RT	A	A	D	RT	DP	DP
Track(Medium Confidence ABT)	A	A	A		RDT	RT	DP				D	RT	DP	
Track(Medium Confidence TBM)	A	A	A		RDT	RT	DP				D	RT	DP	
Possible Facilities Locations	A	A	A		RDT	A	DP	RT			D	RT	DP	
Possible Sensor Locations & Surveillance Standards	A	A	A		RDT	A	DP	RT			D	RT	DP	
Track(Friendly)	RDT	T	T		A	RPT	DP	RT	A	A	D	RT		DP
Track(Threat)	A	A	A		A	RPT		T	A	A	D	RT	DP	DP
Track(CST)	A	A	A		RDT	RT	DP		T	T	D	RT	DP	
Report(Tactical-CST)	A	A	A		RDT	RT	DP		T	T	D	RT	DP	
Track(Weighted)	A	A	A			RT	DP				D	RT	DP	
Report(Tactical Warning)	T	T	T		T	T			T	T		T		
Track(Correlated)	A	A	A		RDT	T					D	RT	DP	
Track(ACE)	A	A	A		A	RPT			A	A	D	RT	DP	DP
Possible Weapons Locations	A	A	A		RDT	A	DP	RT			D	RT	DP	
Report(Tactical)	A	A	A		A	RPT	DP		A	A	D	RT	DP	DP
Track(Defined)	A	A	A		A	A	DP	R	A	A	D	RT	DP	DP
Position Request	A	A	A		RDT	A	DP	RT			D	RT	DP	
Mission (Legal & Political Bounds)						RT	DP	RT			D	RT	DP	
Boundaries (ACE AO)						RT	DP	RT			D			
Boundaries (ACE AOI)						T		T						
Battlespace						T		T						

Figure E.1 (Continued)

Outputs vs. Equipment

Outputs \ Equipment	AN/TPS-59	TADIL A	TADIL B	TADIL C	ATDL-1	LAN/WAN	PC	Tactical Modem	PAR	CWAR	Manual	Tactica Radio	TAOM	BCP
Report(Non-Compliance)	A	A	A		RDT	A	DP	RT			D	RT	DP	
Request(Intelligence-Theater)	A	A	A		RDT	A	DP	RT	T	T	D	RT	DP	
Order(Surveillance)	A	A	A		RDT	T		T			D	RT	DP	
Order(Surveillance, Operating Mode, Readiness State)	A	A	A		RDT	T		T			D	RT	DP	
Tactical Report(ACE)	A	A	A		RDT	R	DP				D	RT	DP	
Report(Threat Composition)	RDT	A	A		A	RPT	DP		A	A	D	RT		DP
Track(Monitored)	RDT	A	A		A	RPT	DP		A	A	D	RT		DP
Tactical Picture	T	T	T		T	T			T	T		T		
Plans(AAW)	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
Plans(Air Defense)	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
Plans(ACP)	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
Plans(AAW Portion of ATO)	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
Plans(Surveillance/Collection)						T		T				T		
Plans	T	T	T	T	T	T		T				T		
Air Superiority Required	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
Allocation Shortfalls	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
Resolved Shortfalls	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
ROE						T		T				T		
Request(Allocation)	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
Request(Combat Service Support)						T		T				T		
Plans(TechOpDat)	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
Plans(EMCON)	RD	RD	RD		RD	A	DP	RT			D	RT	DP	
ACE Assets (Shortfalls)	T	T	T		T	T		T				T		
ACE C3 Architecture (C2 Options)	A	A	A		RDT	A	DP	RT			D	RT	DP	
ACE Assets (Shortfall - C2 & Weapons)	T	T	T		T	T		T				T		
ACE Assets (Weapons - Sitting Options)	T	T	T		T	T		T				T		

Figure E.1 (Continued)

Outputs vs. Equipment

Outputs \ Equipment	AN/TPS-59	TADIL A	TADIL B	TADIL C	ATDL-1	LAN/WAN	PC	Tactical Modem	PAR	CWAR	Manual	Tactical Radio	TAOM	BCP
Plans(Technical Control Procedures)					T	T		T				T		
ACE C3 Architecture(Comm Net & Freq Assign)					T	RT	DP	RT			D	T		
TADIL Interface Options	T	T	T	T	T	T		T				T		
Point-to-Point Options	T				T	T			T	T		T		
LAN/WAN Options						T								
ACE C3 Architecture(Data Options)	T	T	T	T	T	T			T	T		T		
OpOrd(AOE-Annex K-Voice)						RT	DP	RT			D			
Satellite Options						T		T						
Landline Options						T		T						
Radio Options						T		T						
Launch Warning Options														
ACE C3 Architecture(Voice Options)						T		T						
ACE Assets(Shortfalls-Comm)	T	T	T		T	T		T				T		
ACE C3 Architecture(Weighted Comm Options)	RDT	RDT	RDT		RDT	A	DP	RT			D	RT	DP	
Possible Air Facilities Location	A	A	A		RDT	A	DP	RT			D	RT	DP	
Possible Fire Support Coordination Measures	A	A	A		RDT	A	DP	RT			D	RT	DP	
Possible Airspace Control Measures	A	A	A		RDT	A	DP	RT			D	RT	DP	
Possible Air Defense Control Measures	A	A	A		RDT	A	DP	RT			D	RT	DP	
Weight Air Control Architecture	A	A	A		RDT	A	DP	RT			D	RT	DP	
Air Control/Air Direction Authority	A	A	A		RDT	A	DP	RT			D	RT	DP	
ACE Capabilities (Relative Combat Power)	RD	RD	RD		RD	RT	DP	R			D	RT	DP	
Threat ID	RD	RD	RD		RD	RT	DP	RT			D	RT	DP	
Guidance (ACE Priorities & Intent)	RDP	RDP	RDP		RD	A	DP	RT			D	RT	DP	
Time to Intercept Estimates						RT	DP	RT			D	T		
ACE C3 Architecture	T	T	T		T	T		T				T		
ACE C3 Architecture (Casualty Options)	A	A	A		RDT	A	DP	RT			D	RT	DP	

Figure E.1 (Continued)

Equipment vs. TACC - Comm Type - TAOC

R-Receive, T-Transmit

Equipment	TACC		Satellite	Landline	Radio	Point-to-Point		TAOC
AN/TPS-59						X		
TADIL A	RT				X			RT
TADIL B	RT		X	X	X			RT
TADIL C					X			RT
ATDL-1				X	X			RT
LAN/WAN	RT			X	X			RT
PC	R			X	X			R
Tactical Modem	RT			X	X			RT
PAR								
CWAR								
Manual								
Tactical Radio	RT				X			RT
TAOM				X	X	X		RT
BCP								

Figure E.1 (Continued)

Equipment vs. TAOC - Comm Type - BCP

R-Receive, T-Transmit

Equipment	TAOC		Satellite	Landline	Radio	Point-to-Point		BCP
AN/TPS-59	RT					X		
TADIL A	RT				X			
TADIL B	RT		X	X	X			
TADIL C	RT				X			
ATDL-1	RT			X	X			RT
LAN/WAN	RT			X	X			RT
PC	R			X	X			R
Tactical Modem	RT							RT
PAR						X		RT
CWAR						X		RT
Manual								
Tactical Radio	RT				X			RT
TAOM	RT			X	X	X		
BCP				X	X	X		RT

Figure E.1 (Continued)

Intelligence vs. TACC - Equipment - TAOC

R- Receive, T-Transmit
X-TACC, Y-TAOC

Intelligence	TACC		AN/TPS-56	TADIL A	TADIL B	TADIL C	ATDL-1	LAN/WAN	PC	Tactical Modem	PAR	CWAR	Manual	Tactical Radio	TAOM	BCP		TAOC
INTSUM	RT			X	X			XY		X				X				RT
TIBS/TRAP Info	R			X	X			X		X				X				RT
IPBDB Info	RT			XY	XY			XY		XY				XY				RT
Report (ESM)	R			X	X			XY		XY				XY				RT
Report (Intelligence)	RT			X	X			XY		XY				XY				RT
Report (Situation)	RT			X	X			XY		XY				XY				RT
Report (Status)	R			X	X			XY		XY				X				RT
Report (Combat Assessment)	RT			X	X			XY		X				X				RT
Report (Tactical Warning)	RT			XY	XY			XY		XY				XY				RT
Intelligence	RT			X	X			XY		XY				XY				RT
Track (AN/TPS-59 Data)	R			XY	XY			XY		XY				XY				RT
Tactical Picture	RT			X	X			XY		XY				XY				RT
Threat Capabilities	R			XY	XY			XY		XY				XY				RT
Target Identification	R			X	X			XY		XY				X				RT
TG	R			XY	XY			XY		XY				XY				RT
WX	R			X	X			XY		XY				X				RT

Figure E.1 (Continued)

Intelligence vs. TAOC - Equipment - BCP

R-Receive, T-Transmit
X-TAOC, Y-BCP

Intelligence	TAOC	AN/TPS-59	TADIL A	TADIL B	TADIL C	ATDL-1	LAN/WAN	PC	Tactical Modem	PAR	CWAR	Manual	Tactical Radio	TAOM	BCP	BCP
INTSUM	T	Y				Y	XY		XY				XY			R
TIBS/TRAP Info	RT	XY				XY	XY		XY				XY		Y	RT
IPBDB Info	RT	XY				XY	XY		XY				XY			RT
Report (ESM)	RT	XY				XY	XY		XY				XY		Y	RT
Report (Intelligence)	RT	XY				XY	XY		XY				XY		Y	RT
Report (Situation)	T	Y				Y	XY		XY				XY			R
Report (Status)	T	Y				Y	XY		XY				XY			R
Report (Combat Assessment)	RT	XY				XY	XY		XY				XY			RT
Report (Tactical Warning)	RT	XY				XY	XY		XY				XY		Y	RT
Intelligence	RT	XY				XY	XY		XY				XY		Y	RT
Track (AN/TPS-59 Data)	T	Y				Y	XY		XY				XY		Y	R
Tactical Picture	T	Y				Y	XY		XY				XY		Y	R
Threat Capabilities	T	Y				Y	XY		XY				XY		Y	R
Target Identification	RT	XY				XY	XY		XY				XY			RT
TG	T	Y				Y	XY		XY				XY		Y	R
WX	T	Y				Y	XY		XY				XY			R

Figure E.1 (Continued)

E.3 MATRIX FINDINGS

No single matrix represents a summary of all findings. In fact, most matrices lead to a need for further research. The matrices were constructed in such a fashion as to allow each matrix to represent a portion of the overall TBMD system. In some instances the matrices reinforced known conditions. However, when combined and taken as a whole, the matrices provided answers to more specific areas of concern.

The goal of this analysis was to investigate several areas of concern and provide insight and guidance to a proposed 2002 "To Be" Marine Corps TBMD model. Matrix analysis facilitated those goals by providing a comprehensive investigation of the "As Is" Marine Corps TBMD model. The areas of concern include: Intelligence Data Flow, Battle Management Information Architecture Cohesiveness, and Battle Management Information Support.

An example of how the analysis works is as follows: Matrix E.1.3 EQUIPMENT TO C2 FACILITY, provides a wealth of information about what systems are used within the C2 Facilities and how those systems are employed. It also reinforces a known condition of system redundancy. However, the matrix does not provide enough information to answer specific question about information flow or data correlation. When Matrix E.1.3 is combined with Matrix E.1.6 INTELLIGENCE TO C2 FACILITY, Matrix E.1.7 INTELLIGENCE TO EQUIPMENT, and Matrix E.1.13 INTELLIGENCE TO TACC-EQUIPMENT-TAOC, a more comprehensive picture of information flow and data correlation starts to develop.

The matrix findings are described below:

E.3.1 MATRIX 1: C2 FACILITY TO ACTIVITY

Matrix 1 is used to identify which C2 Facility is directly or indirectly related to which activity. If a C2 Facility has a relationship to an activity, an (X) is placed in the intersecting box. If a C2 Facility has no relationship to an activity, the intersecting box is left blank.

Matrix 1 shows that at least one C2 Facility has a relationship with all but eight of the one hundred and sixteen activities (processes) in the Marine Corps "As Is" TBMD system. The relationship is one of three types. The C2 Facility(ies) either monitors the activity, creates the activity, or uses the information from the activity to create specific

information. Four of the eight activities, *Weight Communications Options, Establish Point-to-Point Data Link Options, Establish Launch Warning Options, Create TechOp Data*, are regulated by the communication assets of the ACE. The other four activities, *Conduct Search, Confirm/Engage TEL or Platform, Conduct C2 Warfare, and Conduct Passive Air Defense*, are regulated by aircraft belonging to the ACE.

Matrix 1 represents the first indication of the enormity of the level of involvement required by the C2 Facilities to carry out the TBMD mission. However, it does not, by itself, indicate what information is involved, what equipment is involved, how information is used or how the equipment platforms process the information. When reviewing Matrix 3, EQUIPMENT TO C2 FACILITY, combined with Matrix 6, INTELLIGENCE TO C2 FACILITY, and Matrix 7, INTELLIGENCE TO EQUIPMENT, these issues are better resolved.

E.3.2 MATRIX 2: INTELLIGENCE TO ACTIVITY

Matrix 2 is used to identify which piece of intelligence is directly or indirectly related to which activity. If a piece of intelligence has a relationship to an activity, an (X) is placed in the intersecting box. If a piece of intelligence has no relationship to an activity, the intersecting box is left blank.

Matrix 2 narrows the scope of the flow of information to activities. By concentrating on a specific type of information (i.e., intelligence), a more accurate picture of how information flows throughout the TBMD system is developed. In the matrix, intelligence is seen as either an input or a control. Therefore, it can be ascertained that intelligence is used, either directly or indirectly, as a tool in the process(es) taking place in each activity.

This matrix represents the first indication of the significant level of information is used throughout the TBMD process. However, it does not indicate how the information communicated, what equipment is involved, or how the equipment platforms process the information. Matrix 2 is also an initial indication of the importance of receiving and transmitting information in a timely, accurate fashion. However, by itself, only generalizations can be made.

When matrix 2 is combined with Matrix 6, INTELLIGENCE TO C2 FACILITY, Matrix 7, INTELLIGENCE TO EQUIPMENT, and Matrix 8, INTELLIGENCE TO COMMUNICATION TYPE, a more accurate picture of information use (i.e. format timeliness, equipment capabilities, etc.) can be observed.

E.3.3 MATRIX 3: EQUIPMENT TO C2 FACILITY

Matrix 3 is used to identify whether a piece of communications equipment is located at a particular C2 Facility. This matrix is the first complex matrix constructed. Its parameters represent the many possible relationships that may exist between equipment and C2 Facilities. If a piece of equipment is located within a C2 Facility it is used to receive (R), transmit (T), process (P), display (D) or all (A) of the above. If the piece of equipment is located at the C2 Facility, the appropriate letter or combination of letters is placed in the intersecting box. If the equipment is not located at the C2 Facility, the intersecting box is left blank.

Matrix 3 was developed with three purposes in mind. First, the matrix shows which C2 Facilities contain which types of equipment. Second, it shows how the equipment is employed within the C2 Facility. Finally, and less obvious, because of the information it contains, it is used in the development and analysis of almost every other matrix.

This matrix is an indication of the capabilities of the C2 Facilities to use information. It shows how C2 Facilities can communicate and in which modes they communicate. This matrix is also a prime example of system redundancy. It clearly shows that certain pieces of equipment (TADIL A, TADIL B, LAN/WAN, and Tactical Radio) are capable of doing the same tasks. It is also an indication, to a lessor extent, of the instability of the entire communications network. The instability is due in part to the use of a wide variety of communications equipment. This is explored further in Matrix 7, INTELLIGENCE TO EQUIPMENT. Finally, from this matrix, it is clear that some C2 Facilities cannot communicate in a manner that is timely, thereby making them less efficient. The TAOC (SAAWC) is a prime example. It can receive information from seven different pieces of equipment. However, it can process the information on only two systems.

Combine this information with the analysis of Matrix 11, EQUIPMENT TO TACC-COMM TYPE-TAOC, Matrix 12, EQUIPMENT TO TAOC-COMM TYPE-BCP, Matrix 13, INTELLIGENCE TO TACC-EQUIPMENT-TACO, and Matrix 14, INTELLIGENCE TO TAOC-EQUIPMENT-BCP, it can be ascertained that the communication systems employed in the TBMD architecture are not conducive to effective decision making or mission accomplishment.

E.3.4. MATRIX 4: EQUIPMENT TO COMMUNICATION TYPE

Matrix 4 is used to identify whether a piece of equipment is associated with a particular type of communications. The primary focus of this matrix is the identification of the type of transmissions each piece of equipment employs. If a relationship exists between the piece of equipment and the communications type, an (X) is placed in the intersecting box. If no relationship exists, then the intersecting box is left blank.

Matrix 4 depicts various types of communication uses. It is an indication of redundancy of equipment. All but three of the pieces of equipment use a form of radio transmission. Of those, seven also have landline capabilities. This matrix clarifies, in addition to information from Matrix 3, EQUIPMENT TO C2 FACILITY, and Appendix A, USMC "As Is" TBMD Architecture, a lack of need for the TADIL A.

When information contained in this matrix is combined with Matrix 3, EQUIPMENT TO C2 FACILITY, Matrix 5, COMMUNICATION TYPE TO C2 FACILITY, Matrix 7, INTELLIGENCE TO EQUIPMENT, and Matrix 8, INTELLIGENCE TO COMMUNICATION TYPE, further evidence is examined that indicates the existence of a deficiency with respect to equipment redundancy.

E.3.5 MATRIX 5: COMMUNICATIONS TYPE TO C2 FACILITY

Matrix 5 is used to identify whether or not a communication type is utilized by a C2 Facility. If a communication type is used by a C2 Facility, an (X) is placed in the intersecting box. If the communication type is not employed by a C2 Facility, the intersecting box is left blank.

Matrix 5 is used to support the idea of system redundancy within the C2 Facility environment. All but three C2 Facilities, *GCE (FAC), Commander (CAP), and Special*

Forces, use a form of landlines to communicate. Also, all C2 Facilities use a form of radio communications. This information combined with information contained in Matrix 3, EQUIPMENT TO C2 FACILITY, Matrix 4, COMMUNICATION TYPE TO C2 FACILITY, Matrix 7, INTELLIGENCE TO EQUIPMENT, and Matrix 8, INTELLIGENCE TO COMMUNICATION TYPE, gives a clear picture of the over abundant redundancy of equipment in the C2 Facilities.

E.3.6 MATRIX 6: INTELLIGENCE TO C2 FACILITY

This matrix is used to identify what intelligence information is directly or indirectly utilized by which C2 Facility. This matrix is complex because it presents the many possible relationships that exist between intelligence and C2 Facilities. If a C2 Facility uses a piece of intelligence it will be received (R), transmitted (T), processes (P), displayed (D) or all (A) of the above. If a piece of intelligence is directly or indirectly used by a C2 Facility, the appropriate letter or combination of letters will be placed in the intersecting box. If a piece of intelligence is not used by a C2 Facility, the intersecting box will be left blank.

Matrix 6 presents a picture of which C2 Facilities use what intelligence. It also depicts how the C2 Facilities use intelligence. Except for, *GCE (FAC)* and *Special Forces*, the C2 Facilities receive, process, display, and transmit the different pieces of intelligence.

Matrix 6 reenforces the idea of the importance of information in the C2 Facility within the context of TBMD. Every C2 Facility will handle (receives, transmits, displays, and/or processes) several different types of information in the performance of its mission. The HAWK (TCO), for example, uses ten separate pieces of intelligence in preforming its mission. This matrix also substantiates the notion that the C2 Facilities need to be able to communicate information in a timely, accurate fashion. With the level of information being used within each C2 Facility and the importance of the decisions, it is crucial that the information is communicated in a correct, useable format, as soon as possible.

The information contained in Matrix 6, combined with the information contained in Matrix 2, INTELLIGENCE TO C2 FACILITY, Matrix 11, EQUIPMENT TO TACC-COMM TYPE-TAOC, Matrix 12, EQUIPMENT TO TAOC-COMM TYPE-BCP, Matrix 13, INTELLIGENCE TO TACC-EQUIPMENT-TACO, and Matrix 14, INTELLIGENCE

TO TAOC-EQUIPMENT-BCP, illustrates the importance of reliable information flow between C2 Facilities.

E.3.7 MATRIX 7: INTELLIGENCE TO EQUIPMENT

Matrix 7 is used to identify whether intelligence transmission is associated with a particular piece of equipment. This matrix is complex because it presents many possible relationships between intelligence and equipment. If intelligence is communicated by a piece of equipment it will be received (R), transmitted (T), processed (P), displayed (D) or all (A) of the above. If intelligence is communicated by a piece of equipment, the appropriate letter or combination of letters is placed in the intersecting box. If intelligence is not communicated by a piece of equipment, the intersecting box is left blank.

Matrix 7 is a representation of the mode in which a piece of equipment communicates a piece of intelligence. It is also a strong indicator of equipment capability redundancy within the TBMD environment. Each piece of intelligence is or can be received by at least six or as many as ten different pieces of equipment, transmitted by at least three or as many as ten separate pieces of equipment, processed by at least two or as many as eleven separate pieces of equipment, and displayed by at least seven or as many as twelve different pieces of equipment.

Matrix 7, combined with Matrix 2, INTELLIGENCE TO ACTIVITY, Matrix 4, EQUIPMENT TO C2 FACILITY, Matrix 5, EQUIPMENT TO COMMUNICATION TYPE, Matrix 13, INTELLIGENCE TO TACC-EQUIPMENT-TAOC, and Matrix 14, INTELLIGENCE TO TAOC-EQUIPMENT-BCP, demonstrate the need to trim the amount of equipment used to communicate information.

Matrix 7 also presents an indication of information flow dilemmas. If, for example, IPBDB Info is received by the TAOC (SAAWC), there is a possibility that it can be received from seven separate C2 Facilities, Matrix 6, INTELLIGENCE TO C2 FACILITY, over five separate pieces of equipment, Matrix 3, EQUIPMENT TO C2 FACILITY. This information, in five different formats and being displayed on five separate mediums, has to be correlated and processed. If that is not enough, then the processed information has to be broken down and transmitted out of the TAOC (SAAWC) to the proper C2 Facilities in the appropriate

format. This is a representation of efficiency problems, formatting problems, processing problems, and ultimately, decision making problems.

E.3.8 MATRIX 8: INTELLIGENCE TO COMMUNICATION TYPE

Matrix 8 is used to identify what intelligence information is associated with what communication type. This matrix is semi-complex because it presents two possible relationships that may exist between intelligence and communication type. A piece of intelligence is communicated, the intelligence is either received (R) or transmitted (T) by the communication type. If intelligence is associated with a communication type, the appropriate letter or combination of letters is place in the intersecting box. If intelligence is not associated with a communication type, the intersecting box will be left blank.

Matrix 8 depicts the various types of communication uses in relationship to intelligence. It is an indication that there is redundancy of the equipment. Every piece of intelligence is received and transmitted by radio and land line communications. The clearest point this matrix supports, in conjunction with Matrix 3, EQUIPMENT TO C2 FACILITY, and Appendix A, USMC "As Is" TBMD Architecture, is a need to streamline the equipment types used in the TBMD process.

If , for example, the TAOC (SID) needed the Tactical Warning Report, Matrix 6, INTELLIGENCE TO C2 FACILITY to make a decision. First, the Tactical Warning Report can be transmitted by ten separate pieces of equipment, Matrix 7, INTELLIGENCE TO EQUIPMENT. Of these ten types of equipment, the TAOC (SID) has five that can receive information, Matrix 3, EQUIPMENT TO C2 FACILITY. Of these five pieces of equipment, four communicate information via a radio, two of those four also communicate information via landline, and one communicates information via point-to-point, Matrix 4, EQUIPMENT TO COMMUNICATION TYPE. The TAOC (SID) can communicate using each of these three methods, Matrix 5, COMMUNICATION TYPE TO C2 FACILITY. In effect, the TAOC (SID) has five pieces of communications equipment it can receive the Tactical Warning Report on. Why it is necessary to have so many?

E.3.9 MATRIX 9: OUTPUTS TO C2 FACILITY

Matrix 9 is used to identify which outputs are directly or indirectly utilized by which C2 Facilities. Also, this matrix is used to identify general information flows within the C2 Facilities. The matrix is complex because it presents the many possible relationships that may exist between output and C2 Facilities. If an output is used by a C2 Facility, the output is received (R), transmitted (T), processed (P), displayed (D) or all (A) of the above. If a relationship exists, the appropriate letter or combination of letters is placed in the intersecting box. If no relationship exists, the intersecting box is left blank.

Matrix 9 demonstrates the enormity of information that flows to and from the C2 Facilities. The matrix is used to demonstrate that all, but two, of the outputs in the model are related to C2 Facilities. Only *Threat Warning* and *Launch Warning Options* are not associated with a C2 Facility. It also shows how the outputs are related to the C2 Facilities.

For example, Target Information is transmitted by both the TAOC (SWD) and the TAOC(SAAWC). That information is received, displayed and processed by the ACE Battlestaff (COS) and the HAWK (TCO). The HAWK (TCO) also transmits Target Information to the ACE Battlestaff (COS). This is a prime example of the information flow within the TBMD system. The TAOC transmits Target Information to the HAWK Battalion which receives, displays and processes the information. The HAWK Battalion, once they have correlated the data, then transmits their Target Information to the ACE Battlestaff. The ACE Battlestaff receives the Target Information from both the TAOC and the HAWK Battalion and uses the information to monitor the situation.

Matrix 9 is also an indicator of the need for timely, accurate communications between C2 Facilities. Once again, Target Information is a prime example. The HAWK (TCO) cannot react to a track very well if the TAOC does not identify to them the presence of a possible target and the classification of the target.

The information contained in matrix 9 combined with information from Matrix 1, C2 FACILITY TO ACTIVITY, Matrix 2, INTELLIGENCE TO ACTIVITY, Matrix 6, INTELLIGENCE TO C2 FACILITY, and Matrix 10, OUTPUTS TO EQUIPMENT, identify the need for timely, accurate communications within the TBMD system. This combination

of matrices also is an indication of how large a role information plays in the entire process. Finally, Matrix 1, Matrix 2, Matrix 9, and Matrix 10 form the foundation for the analysis of the model.

E.3.10 MATRIX 10: OUTPUTS TO EQUIPMENT

Matrix 10 is used to identify which outputs are communicated through which types of equipment. Also, the matrix is used to identify the role of equipment in the flow of information. The matrix is complex because it presents the many possible relationships that may exist between outputs and equipment. If an output is communicated through a piece of equipment it is received (R), transmitted (T), processed (P), displayed (D) or all (A) of the above. If the relationship exists, the appropriate letter or combination of letters is placed in the intersecting box. If no relationship exists, the intersecting box is left blank.

Matrix 10, like Matrix 7, INTELLIGENCE TO EQUIPMENT, demonstrates the problem of equipment redundancy. For all, but two, of the outputs there are at least two or as many as thirteen pieces of equipment that are used to facilitate communications. ID Threat information, for example, is capable of being received by ten separate pieces of equipment, displayed by eleven different pieces of equipment, processed by ten separate pieces of equipment, and transmitted by six different pieces of equipment. This is definitely equipment redundancy.

Matrix 10, when combined with other matrices is also an indication of the problems associated with communicating information via more than one type of equipment. Launch/Impact Point is a simple example of this phenomenon. The Launch/Impact Point information is transmitted by the HAWK (TCO) and received, displayed and processed by the TAOC (SWD) and TAOC (SAAWC), Matrix 9, OUTPUTS TO C2 FACILITIES. The HAWK (TCO) uses six different systems to transmit information while the TAOC (SWD) and the TAOC (SAAWC) have six, respectively, pieces of equipment that can receive information from the HAWK (TCO), Matrix 3, EQUIPMENT TO C2 FACILITY. Of the six pieces of equipment the HAWK (TCO) has, four can be found in either the TAOC (SWD) or the TAOC (SAAWC) or at both C2 Facilities. Also, both the TAOC (SWD) and the TAOC (SAAWC) process the information on different equipment. This means that the

HAWK (TCO) has to send the information out in more than one format in order for it to be useful. This is both time consuming and ineffective for all three C2 Facilities.

E.3.11 MATRIX 11: EQUIPMENT TO TACC-COMM TYPE-TAOC

Matrix 11 is used to demonstrate two separate two-dimensional relationships. First, this matrix examines the relationship between information flow from the TACC to the TACO. This is accomplished by examining the types of equipment used by the two facilities to pass information. Either one of two relationships exists. Either the TACC transmits (T) or receives (R) information using the type of equipment or the TAOC receives or transmits information with the type of equipment. If the relationship exists, the appropriate letter or combination of letters is placed in the intersecting box. If the relationship does not exist, the intersecting box is left blank.

Second, the matrix is used to examine how the information is passed between two facilities. Once the relationship between equipment and the two C2 Facilities is established, then the relationship between the equipment and communication type can be examined. If there is a relationship between equipment and communication type, an (X) is placed in the intersecting box. If no relationship exists, the intersecting box is left blank.

In the analysis of this matrix, there is a dual focus. The primary focus is on the type of equipment that passes information between the TACC and the TAOC. The secondary focus is on the communication type used by the equipment to pass the information. If a piece of information is communicated by more than one type of equipment, there may be an opportunity to reduce the number of systems that preform that function. This only holds true if the equipment is not mission essential (i.e., the removal of a piece of equipment does not hinder the effectiveness of the facility).

When reviewing the equipment used to communicate information between the TACC and the TAOC, two topics need to be addressed. First, is there a communication problem due the equipment? Second, is there system redundancy? With the information contained in this matrix, combined with the information in Matrix 3, EQUIPMENT TO C2 FACILITY, both questions can be answered. In order for the TACC to communicate with the TAOC both C2 Facilities have to be able to receive, transmit, process, and display information in

a timely, efficient manner. These qualities have to be present in order for the facilities to effectively carry out their missions.

Both questions can be answered by citing one example. Both C2 Facilities have LAN/WAN capabilities present in their respective facilities. The LAN/WAN is capable of receiving and transmitting in the majority of the TACC commands. The ACE Battlestaff (COS) is the only one to have receiving, transmitting, and processing capabilities using the LAN/WAN, Matrix 3. In most cases, to display and process information, the TACC must use a separate piece of equipment. However, in the TAOC, only one command, the SAAWC, has LAN/WAN capabilities at all. Fortunately, it possesses all four capabilities, Matrix 3. Upon further inspection, the TACC also has four other types of equipment that can receive and transmit information and of those four only two can process and display the information. The TAOC, on the other hand, has five separate pieces of equipment that can receive, transmit, process, and display information, two pieces of equipment that can receive and transmit information, and two pieces of equipment that can display and process information. With all these systems available to each command, why is it that information can only be received and transmitted on one type of equipment and displayed and processed on another type of equipment? This is, of course, except for the five cases case where the ACE Battlestaff (ICO/TDC) communicates with the TAOC(SAAWC), Matrix 6, INTELLIGENCE TO C2 FACILITY. There is system redundancy present in this instance (the two facilities both contain six separate pieces of equipment). However, the problem is that the equipment is not being used to it's fullest capabilities. This effects timeliness (receive and transmit on one type of equipment then display and process on another piece of equipment), efficiency (time is lost due to the switch in equipment during the display and process phases) , and information adequacy (information can be received in a number of different formats over several different pieces of equipment). It also affects the decision making process by not providing adequate information in a timely manner.

When reviewing the communication types used by equipment to pass information between the TACC and the TAOC, two topics need to be addressed. First, does the communication type effect the format of the information? Second, is one communication

type better for transmitting and receiving information? With the information contained in this matrix, combined with the information in Matrix 3, EQUIPMENT TO C2 FACILITY, Matrix 4, EQUIPMENT TO COMMUNICATION TYPE, Matrix 5, COMMUNICATION TYPE TO C2 FACILITY, Matrix 7, INTELLIGENCE TO EQUIPMENT, and Matrix 8, INTELLIGENCE TO COMMUNICATION TYPE, these questions can be addressed. In order for the TACC and the TAOC to communicate effectively, information has to be passed in a format that is conducive to timely, efficient processing.

In Matrix 7, INTELLIGENCE TO EQUIPMENT, it is shown that the type of equipment has a direct effect on the format of information. Given this, and since Matrix 4, EQUIPMENT TO COMMUNICATION TYPE, displays the relationship that exists between equipment and communication type, then it holds true that the communication type will have a direct effect on the information format.

Using an example from Matrix 7, it is possible that IPBDB Info can be received by the TAOC (SAAWC) from five separate TACC commands, (Matrix 6, INTELLIGENCE TO C2 FACILITY), over five separate pieces of equipment, (Matrix 3, EQUIPMENT TO C2 FACILITY). From Matrix 11, over those five pieces of equipment, it is possible that the information could be received using one of three different communication modes. This information, being transmitted in five different formats, using three communication modes and being displayed on four possible mediums, has to be correlated and processed. If that were not enough, the processed information has to be broken down (transformed) and transmitted out of the TAOC (SAAWC) to the proper C2 Facilities in the appropriate format. This is a representation of efficiency problems, formatting problems, processing problems, and ultimately, decision making problems.

By examining the information contained in this matrix and combining it with information in Matrix 3, EQUIPMENT TO C2 FACILITY, the second question can be addressed. The TACC and the TAOC, in the majority of instances, would use the LAN/WAN, Tactical Modem or Tactical Radio to receive and transmit information, (Matrix 3). The LAN/WAN and Tactical Modem use landline and radio as their communication mode and Tactical Radio uses radio as its communication mode, (Matrix 11). There is no

way to decipher if one communication type or another is better. More than likely both types are used. For example, one form, radio, would be used as the primary means to communicate, while the other, landline, would be used as the backup.

E.3.12 MATRIX 12: EQUIPMENT TO TAOC-COMM TYPE-BCP

Matrix 12 is used to demonstrate two separate two-dimensional relationships. First, this matrix examines the relationship between information flow from the TAOC to the BCP. This is accomplished by examining the types of equipment used by the two facilities to pass information. Either one of two relationships exists. Either the TAOC transmits (T) or receives (R) information using the type of equipment or the BCP receives or transmits information with the type of equipment. If the relationship exists, the appropriate letter or combination of letters is placed in the intersecting box. If the relationship does not exist, the intersecting box is left blank.

Second, the matrix is used to examine how the information is passed between two facilities. Once the relationship between equipment and the two C2 Facilities is established, then the relationship between the equipment and communication type can be examined. If there is a relationship between equipment and communication type, an (X) is placed in the intersecting box. If no relationship exists, the intersecting box is left blank.

In the analysis of this matrix, there is a dual focus. The primary focus is on the type of equipment that passes information between the TAOC and the BCP. The secondary focus is on the communication type used by the equipment to pass the information. If a piece of information is communicated by more than one type of equipment, there may be an opportunity to reduce the number of systems that preform that function. This only holds true if the equipment is not mission essential (i.e., the removal of a piece of equipment does not hinder the effectiveness of the facility).

When reviewing the equipment used to communicate information between the TAOC and the BCP, two topics need to be addressed. First, does the piece of equipment used to communicate information matter? Second, is there system redundancy? With the information contained in this matrix, combined with the information in Matrix 3, EQUIPMENT TO C2 FACILITY, both questions can be answered. In order for the TAOC

to communicate with the BCP both C2 Facilities have to be able to receive, transmit, process, and display information in a timely, efficient manner. These qualities have to be present in order for the facilities to effectively carry out their missions.

Both questions can be answered by citing one example. Both C2 Facilities have LAN/WAN capabilities present in their respective facilities. The LAN/WAN is capable of receiving and transmitting in the majority of the TAOC commands. The TAOC (SAAWC) is the only one to have receiving, transmitting, displaying, and processing capabilities using the LAN/WAN, (Matrix 3). In the BCP, only the HAWK (TCO) has LAN/WAN capabilities. Unfortunately, it possesses only three (receive, transmit and process) of the four capabilities, (Matrix 3). In order to display information received, the HAWK (TCO) has to use another piece of equipment. Upon further inspection, of the nine pieces of equipment available to the TAOC, five pieces of equipment can receive, transmit, process, and display information, two pieces of equipment can receive and transmit information, and two pieces of equipment can display and process information. The BCP, on the other hand, has three additional pieces of equipment that can receive, transmit, display, and process information, two pieces of equipment that are capable of receiving and transmitting information, and one piece of equipment that can display and process information, (Matrix 3). With all these systems available to each command, why is it that information is, except for when the TAOC (SAAWC) communicates with the HAWK (TCO), (Matrix 6), received and transmitted on three types of equipment and displayed and processed on two other piece of equipment? The answer is system redundancy present in this instance (the two facilities contain four of the same type of equipment and five different types of equipment). However, the problem is that the equipment is not being used to it's fullest capabilities. This effects timeliness (receive and transmit on one type of equipment then display and process on another piece of equipment), efficiency (time is lost due to the switch in equipment during the display and process phases), and information adequacy (information can be received in a number of different formats over several different pieces of equipment). It also affects the decision making process by not providing adequate information in a timely manner.

When reviewing communication type used by the equipment to pass information between the TAOC and the BCP, two topics need to be addressed. First, does the communication type effect the format of the information? Second, is one communication mode better for transmitting and receiving information? With the information contained in this matrix, combined with the information in Matrix 3, EQUIPMENT TO C2 FACILITY, Matrix 4, EQUIPMENT TO COMMUNICATION TYPE, Matrix 5, COMMUNICATION TYPE TO C2 FACILITY, Matrix 7, INTELLIGENCE TO EQUIPMENT, and Matrix 8, INTELLIGENCE TO COMMUNICATION TYPE, these questions can be addressed. In order for the TAOC and the BCP to communicate effectively, information has to be passed in a format that is conducive to timely, efficient processing.

In Matrix 7, INTELLIGENCE TO EQUIPMENT, it is shown that the type of equipment has a direct effect on the format of information. Given this, and since Matrix 4, EQUIPMENT TO COMMUNICATION TYPE, displays the relationship that exists between equipment and communication type, then it holds true that the communication mode will have a direct effect on the information format.

Using an example from Matrix 7, it is possible that Track (AN/TPS-59 Data) intelligence can be received by the BCP from four separate TAOC commands, (Matrix 6, INTELLIGENCE TO C2 FACILITY), over five separate pieces of equipment, (Matrix 3, EQUIPMENT TO C2 FACILITY). From Matrix 11, over those four pieces of equipment, it is possible that the information could be received using one of two communication types. This information, being transmitted in five different formats, using two communication types and being displayed on three possible mediums, has to be correlated and processed. If that were not enough, the processed information has to be broken down (transformed) and transmitted out of the BCP to the proper C2 Facilities in the appropriate format. This is a representation of efficiency problems, formatting problems, processing problems, and ultimately, decision making problems.

By examining the information contained in this matrix and combining it with information in Matrix 3, EQUIPMENT TO C2 FACILITY, the second question can be addressed. The TAOC and the BCP, in the majority of instances, would used the ATDL-1,

LAN/WAN, or Tactical Radio to receive and transmit information, (Matrix 3). The ATDL-1 and LAN/WAN use landline and radio as their communication type and Tactical Radio uses radio as its communication type, (Matrix 11). There is no way to decipher if one communication type or another is better. More than likely both modes are used. For example, one form, radio, would be used as the primary means to communicate, while the other, landline, would be used as the backup.

E.3.13 MATRIX 13: INTELLIGENCE TO TACC-EQUIPMENT-TAOC

Matrix 13 is used to demonstrate two separate two-dimensional relationships. First, the matrix examines the flow of intelligence between the TACC and the TAOC. This is accomplished by examining the types of intelligence used by the two facilities both separately and combined. Either one of two relationships exists. The TACC either transmits (T) or receives (R) intelligence or the TAOC transmits or receives intelligence. If the relationship exists, the appropriate letter or combination of letters is placed in the intersecting box. If no relationship exists, the intersecting box is left blank.

Second, the matrix is used to examine the relationship between intelligence and the type of equipment used to communicate the intelligence to or from the two facilities. This matrix also examines the type of equipment located at the two facilities. Once the relationship between the piece of intelligence and the two facilities is established, then the relationship between the intelligence, equipment, and the facility can be examined. If there is a relationship between intelligence an equipment type, and (X) is placed in the intersecting box if the equipment is located in the TACC or a (Y) is placed in the intersecting box if the equipment is located in the TAOC. There is also the possibility that the equipment is located in both facilities. If this is true, than a combination of the two letters will appear in the intersecting box. If there is no relationship, the intersecting box is left blank.

In the analysis of this matrix, there is a dual focus. The primary focus is on the systems that pass intelligence between the TACC and the TAOC. The secondary focus is on the intelligence flow between the two facilities. If a piece of intelligence is communicated by more than one type of equipment, there may be an opportunity to reduce the number of systems that preform that function. This only holds true if the equipment is

not mission essential (i.e., the removal of a piece of equipment does not hinder the effectiveness of the facility).

When reviewing the equipment used to communicate intelligence between the TACC and the TAOC two topics need to be addressed. First, does the equipment support the mission of the C2 Facility? Second, is the intelligence being received in a timely fashion? First, the missions of the two C2 facilities needs to be addressed. The TACC functions as the combat operations center for the Aviation Combat Element (ACE) of the Marine Air Ground Task Force (MAGTF). It is the senior agency within the Marine Air Command and Control System (MACCS) and as such, is responsible for the overall supervision, coordination, and control of tactical air operations in the Marine corps area of responsibility. The TACC supports three basic functions; Command, Operations, and Planning [Ref. 12]. The mission of the TAOC is to act as the senior air defense agency within its assigned sector of responsibility. The TAOC performs the functions of air surveillance and early warning, aircraft control, and controls all surface to air missile fires within its assigned sector [Ref. 12]. With the information in this matrix and information contained in Matrix 3, EQUIPMENT TO C2 FACILITY, Matrix 6, INTELLIGENCE TO C2 FACILITY, Matrix 9, OUTPUTS TO C2 FACILITY, and Matrix 10, OUTPUTS TO EQUIPMENT the questions can be answered. In order for the TACC to perform its mission it must be able to receive, display and process information from many different sources. At the same time, however, once the information is correlated, the TACC must be able to transmit this information to the TACC.

Both questions can be addressed using the same example. Report (ESM) is a piece of intelligence that consist of information from many sources. Some of those sources are the GCE (FSCC), the GCE (FAC), the HAWK (TCO), Special Forces and Artillery, (Matrix 6). The information is transmitted to and from the TACC from the different sources via LAN/WAN, Tactical Modem and Tactical Radio, (Matrix 3). In almost all instances, however, the intelligence is processed and displayed by different pieces of equipment within the TACC. The JTF Commander, the ACE Battlestaff (MACCS(DASC)) and the ACE Commander process information on the PC and display information on the PC or manually,

(Matrix 3). On the other hand, the Commander (CAP) and the ACE Battlestaff (COS) display and process the Report (ESM) on the TADIL C and TADIL A and TADIL B respectively, (Matrix 3). This is an indication that information is not being processed and correlated in a timely fashion. Almost every command, located in the C2 Facility, is displaying and processing the same information on three and sometimes four different pieces of equipment.

Once the information has been correlated it is sent to the TAOC by means of a LAN/WAN, Tactical Modem or Tactical Radio, (Matrix 13 and Matrix 3). This is a good example of the equipment (LAN/WAN, Tactical Modem and Tactical Radio) supporting the mission. It is also a case of system redundancy. There are three separate systems capable of doing the same function.

There is another area of concern within this context. The TACC has within its boundaries the entire ACE Battlestaff, the JFC (Political Advisor), the JTF Commander, and the ACE Commander. With these commands come almost every piece of communications equipment in the TBMD architecture, (Matrix 3). However, these systems are not being used to their fullest advantage. Different types of equipment possess different capabilities within the confines of their respective C2 Facilities. For example, the ACE Battlestaff (COS) has TADIL A and TADIL B equipment, but the capabilities are limited to display and process. The same can be said for the TAOC. Even though the SAAWC is the only command within the TAOC receiving Report (ESM) information from the TACC, it is not using its TADIL capabilities to their fullest extent. Both of these examples demonstrate the lack of cohesion necessary to communicate data in a timely, efficient, adequate manner. Either the systems that exist need to be brought on-line to their fullest capabilities or they need to be replaced with a system that will provide timely, efficient, adequate communications between C2 Facilities.

In recognizing the flow of intelligence between the two facilities, two areas of concern are addressed by this matrix. First, who uses what pieces of intelligence? Second, is the intelligence received in a format that is conducive to efficient decision making? The first question is readily answered by the matrix. Every piece of intelligence is used by the

two facilities. The information that is needed by the TAOC to conduct its mission is transmitted by the TACC and received by the TAOC. Also, the intelligence necessary for two facilities to perform their mission is received and transmitted both ways. What is not apparent in the matrix is format that in which intelligence is received or transmitted.

However, if careful attention is paid to the equipment type used to communicate the intelligence, it is clear that at least three and sometimes four different formats are used. The information in this matrix, combined with the information contained in Matrix 3, EQUIPMENT TO C2 FACILITY, Matrix 4, EQUIPMENT TO COMMUNICATION TYPE, and Matrix 7, INTELLIGENCE TO EQUIPMENT, will demonstrate the likelihood of what format is used in each case.

For example, from the matrix, the intelligence, Threat Capabilities, is transmitted by the TACC and received and transmitted by the TAOC. It is also apparent (because the pieces of equipment are present at both facilities) that the information will be transmitted and received by one of three pieces of equipment, LAN/WAN, Tactical Modem or Tactical Radio. From Matrix 7, INTELLIGENCE TO EQUIPMENT, the LAN/WAN has the capabilities to receive, display, process, and transmit information, the Tactical Modem only has the capability to receive and transmit information, and the Tactical Radio only has the capability to receive and transmit information. This, therefore, narrows the choices of communication to LAN/WAN because of its full compliment of capabilities. Now, Matrix 3, EQUIPMENT TO C2 FACILITY, shows that the TAOC (SAAWC), which is the command for the TAOC, receives, transmits, displays and processes information via the LAN/WAN. This shows that anything not transmitted via the LAN/WAN must be displayed by the PC, equipment inherent to the TAOM, or manually. Therefore, to conduct efficient communication between the TACC and TAOC, all intelligence and information must be transmitted and received via the LAN/WAN. Once again this also shows how inadequate the entire communications system is.

E.3.14 MATRIX 14: INTELLIGENCE TO TAOC-EQUIPMENT-BCP

Matrix 14 is used to demonstrate two separate two-dimensional relationships. First, the matrix examines the flow of intelligence between the TAOC and the BCP. This is

accomplished by examining the types of intelligence used by the two facilities both separately and combined. Either one of two relationships exists. The TAOC either transmits (T) or receives (R) intelligence or the BCP transmits or receives intelligence. If the relationship exists, the appropriate letter or combination of letters is placed in the intersecting box. If no relationship exists, the intersecting box is left blank.

Second, the matrix is used to examine the relationship between intelligence and the type of equipment used to communicate the intelligence to or from the two facilities. This matrix also examines the type of equipment located at the two facilities. Once the relationship between the piece of intelligence and the two facilities is established, then the relationship between the intelligence, equipment, and the facility can be examined. If there is a relationship between intelligence and equipment type, an (X) is placed in the intersecting box if the equipment is located in the TAOC or a (Y) is placed in the intersecting box if the equipment is located in the BCP. There is also the possibility that the equipment is located in both facilities. If this is true, a combination of the two letters will appear in the intersecting box. If there is no relationship, than the intersecting box is left blank.

In the analysis of this matrix, there is a dual focus. The primary focus is on the systems that pass intelligence between the TAOC and the BCP. The secondary focus is on the intelligence flow between the two facilities. If a piece of intelligence is communicated by more than one type of equipment, there may be an opportunity to reduce the number of systems that preform that function. This only holds true if the equipment is not mission essential (i.e., the removal of a piece of equipment does not hinder the effectiveness of the facility).

When reviewing the equipment used to communicate intelligence between the TAOC and the BCP two topics need to be addressed. First, does the equipment support the mission of the C2 Facility? Second, is the intelligence being received in a timely fashion? First, the missions of the two C2 facilities needs to be addressed. The mission of the TAOC is to act as the senior air defense agency within its assigned sector of responsibility. The TAOC performs the functions of air surveillance and early warning, aircraft control, and controls

all surface to air missile fires within its assigned sector [Ref. 12]. The mission of the BCP is to function as the control facility for the HAWK surface to air missile system [Ref. 12].

With the information in this matrix and information contained in Matrix 3, EQUIPMENT TO C2 FACILITY, Matrix 6, INTELLIGENCE TO C2 FACILITY, Matrix 9, OUTPUTS TO C2 FACILITY, and Matrix 10, OUTPUTS TO EQUIPMENT the first question can be answered. In order for the TAOC to perform its mission it must be able to receive, display and process information from many different sources. At the same time, however, once the information is correlated, the TAOC must be able to transmit this information to the BCP.

Report (Situation), for example, is a piece of intelligence that consist of information from many sources. Two of those sources are the ACE Commander and the ACE Battlestaff (FOS), (Matrix 6). The information is transmitted to the TAOC (SAAWC) via LAN/WAN and/or Tactical Modem, (Matrix 3). It can also come from the ACE Commander via the Tactical Radio, (Matrix 3). In both instances, however, the intelligence is processed by a PC and displayed either on the PC or manually, (Matrix 3). Once the information has been correlated it is sent to the BCP by means of a LAN/WAN, Tactical Modem or Tactical Radio, (Matrix 14 and Matrix 3). This is a good example of the equipment (LAN/WAN, Tactical Modem and Tactical Radio) supporting the mission. It is also a case of system redundancy. There are three separate systems capable of doing the same function.

However, there is also an underlying factor to consider here. Both the TAOC and the BCP have the ATDL-1 equipment at their disposal. The BCP can receive, display, process, and transmit the Report (Situation) using the ATDL-1, (Matrix 3 and Matrix 14). The TAOC, on the other hand, can only receive and display Report (Situation) information using the ATDL-1. This is definitely a case of equipment not supporting the mission. The answer is to either eliminate the piece of equipment from both facilities or bring the process and transmit functions on-line at the TAOC. Note also, the TAOC has other equipment (TADIL A and TADIL B) at its site that has the same capabilities of receiving and displaying, (Matrix 3). These systems are also available to the ACE Commander for display purposes only, (Matrix 3). Yet again there are systems that are not being used to their fullest extent.

The second question can be answered with another example. Target Identification information is being communicated back and forth (received and transmitted) between the TAOC and the BCP using five separate systems, (Matrix 3 and Matrix 14). However, this intelligence is being displayed and/or processed by seven and four pieces of equipment respectively, (Matrix 3). This is a clear indication that information is not being received in a useable format in a timely fashion.

In recognizing the flow of intelligence between the two facilities, two areas of concern are addressed by this matrix. First, who uses what pieces of intelligence? Second, is the intelligence received in a format that is conducive to efficient decision making? The first question is readily answered by the matrix. Every piece of intelligence is used by the two facilities. The information that is needed by the BCP to conduct its mission is transmitted by the TAOC and received by the BCP. Also, the intelligence necessary for two facilities to perform their mission is received and transmitted both ways. What is not apparent in the matrix is format that in which intelligence is received or transmitted.

However, if careful attention is paid to the equipment type used to communicate the intelligence, it is clear that at least three and sometimes four different formats are used. The information in this matrix, combined with the information contained in Matrix 3, EQUIPMENT TO C2 FACILITY, Matrix 4, EQUIPMENT TO COMMUNICATION TYPE, and Matrix 7, INTELLIGENCE TO EQUIPMENT, will demonstrate the likelihood of what format is used in each case.

For example, from the matrix, the intelligence, Threat Capabilities, is transmitted by the TAOC and received by the BCP. It is also apparent (because the pieces of equipment are present at both facilities) that the information will be transmitted and received by one of three pieces of equipment, LAN/WAN, Tactical Modem or Tactical Radio. From Matrix 7, INTELLIGENCE TO EQUIPMENT, the LAN/WAN has the capabilities to receive, display, process, and transmit information, the Tactical Modem only has the capability to receive and transmit information, and the Tactical Radio only has the capability to receive and transmit information. This, therefore, narrows the choices of communication to LAN/WAN because of its full complement of capabilities. Now, Matrix 3, EQUIPMENT TO C2 FACILITY,

shows that the HAWK (TCO), which is the C2 Facility for the BCP, only receives, transmits and processes information via the LAN/WAN. This means that the LAN/WAN, even though it is capable, cannot be used to display the intelligence in the BCP. The only display capability at the BCP is through equipment inherent to the BCP or through manual means. This is an indication of three things. First, the equipment at the BCP is not being used to its fullest capabilities. Second, extra time has to be spent at the BCP to display the intelligence received over the LAN/WAN. Third, redundancy of equipment does not necessarily mean that the capabilities remain the same.

E.4 MATRIX SUMMARY

Some general conclusions from the matrix analysis include the following:

- Because of the multitude of different equipment platforms located at each C2 Facility, there is an inability to communicate in a timely, efficient, accurate means. In effect, because information is received and transmitted over these many types of equipment, the information is not and cannot be effectively displayed and process (correlated and fused) in a fashion conducive to effective decision making.

- Many types of identical equipment, even when located at two communicating C2 Facilities, do not perform the same functions. For reasons unknown, certain attributes of the equipment are either not employed or are not available at certain C2 Facilities. This necessitates the configurations seen in the "As Is" architecture. It has also lead to efficiency and accuracy problems in terms of information flow.

- Many different types of equipment, in the TBMD system, perform the same function. The enormity of the system and the lack of equipment attributes at certain facilities have lead to the fragileness of this systems and have hampered interoperability. There may be an opportunity to eliminate duplicate equipment and develop a target system that could ultimately result in more efficient communications within the TBMD system.

- Information flow (i.e., format, accuracy, timeliness, etc.) is very important within the TBMD system. Without the needed intelligence and additional information, C2 Facilities cannot effectively carry out their missions. However, the architecture is arranged in such a fashion, it actually hinders the flow of information between C2 Facilities.

In performing the matrix analysis, it was necessary to keep in mind some key factors that may be underlying causes of all the matrix findings:

- The Marine Corps "As Is" TBMD architecture came about because of a deficiency identified during the Persian Gulf War. It was crucial to put into place a system that could deal with the problems associated with MAGTF operation against an enemy with Theater Missile capabilities. Once an initial system was in place, there exists an opportunity to refine the system to meet the needs of the Marine Corps. However, first, the system, any system, had to be in place. For the Marine Corps, the obvious choice, because of its system capabilities, was the HAWK Missile system.

- Once the TBMD system was established, the associated problems could be dealt with as they were encountered. First, increase the HAWK Missile system capabilities to include TBMD. Second, increase the capabilities of the AN/TPS-59 radar to include complete coverage of the MAGTF's area of operations. Third, configure the TBMD system to ensure a seamless information architecture is established. Finally, ensure the TBMD system is configured to maximize interoperability.

Overall, the matrix analysis merely confirmed many of the improvement opportunities that NCCOSC, MCCDC, and the author had identified prior to and during the activity and data modeling portions of the TBMD project. However, this does not downplay the importance of using matrix analysis as part of the TBMD project. It does confirm the existence of many challenges facing the TBMD community on the road to achieving a seamless information architecture.

APPENDIX F. USMC "TO BE" ARCHITECTURE

A. USMC "TO BE" AAW/TMD HAWK CONFIGURATION

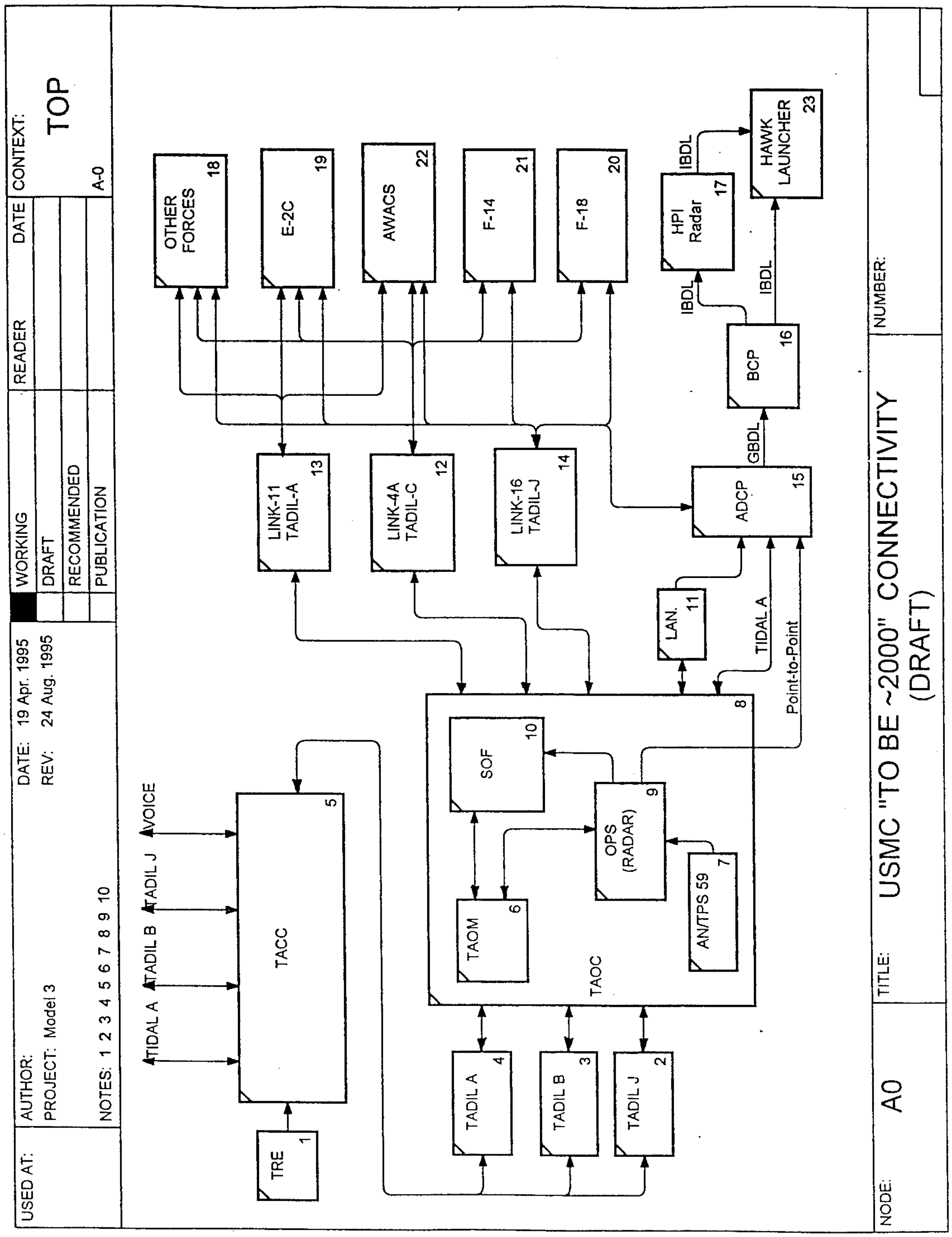
The proposed "To Be" model is only one possible architecture for the Marine Corps' TMD system. The "To Be" model (Figure F.1) will mirror the "As Is" model except for three additions. First, The BCP will no longer be directly linked to the TAOC. Communications will be facilitated through an Air Defense Communication Platform (ADCP). The ADCP will be linked, via a LAN, Point-to-Point, and TADIL A, to the TAOC and other agencies. The next change will occur within the TAOC. A Sector Anti-Air Warfare Coordination Operations Facility (SOF) will be located within the TAOC. The SOF will be linked, via a LAN, to the TAOM and the Operations Center. The final change will occur with the communication equipment. TADIL J will be introduced into the TACC, the TAOC, and the ADCP. The TAOC will add the TADIL J link to its components to facilitate communications between itself , the TACC, friendly aircraft, and friendly forces. The TACC will no longer have a direct connection to other forces via TADIL A. It will, instead, add TADIL J to its communication components to facilitate communication with other agencies and with the TAOC.

B. CONFIGURATION ADDITIONS

1. Sector Anti-Air Warfare Coordination (SAAWC) Operations Facility (SOF)

SOF was moved into the TAOC to manage functions once handled at the TACC and the TAOC. The idea of the SOF came from the Navy's SAAWC concept, however, the Marine Corps SAAWC coordinator is not the Commander. The SAAWC provides an interface between the TAOC weapons section, TACC Battle Staff, and adjacent AAW agencies.

The SOF is responsible for initial and on going planning for near term air operation and for the management of air defense assets by:


USED AT:
AUTHOR:
PROJECT: Model 3
NOTES: 1 2 3 4 5 6 7 8 9 10
DATE: 19 Apr. 1995
REV: 24 Aug. 1995
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CONTEXT:
TOP
A-0
TIDAL A
TADIL B
TADIL J
VOICE
TRE 1
TACC 5
TADIL A 4
TADIL B 3
TADIL J 2
TAOC
TAOM 6
SOF 10
OPS (RADAR) 9
AN/TPS 59 7
8
LAN. 11
Point-to-Point
TIDAL A
ADCP 15
GBDL
BCP 16
IBDL
HPI Radar 17
IBDL
HAWK LAUNCHER 23
LINK-11 TADIL-A 13
LINK-4A TADIL-C 12
LINK-16 TADIL-J 14
OTHER FORCES 18
E-2C 19
AWACS 22
F-14 21
F-18 20
NODE: A0
TITLE: USMC "TO BE ~2000" CONNECTIVITY (DRAFT)
NUMBER:

Figure F.1

- Recommending ATO changes and SAW redeployment.

- Maintaining situation awareness.

- Directing the tailored application of allocated air defense assets to meet near term battle requirements.

- Coordinating air defense operations with other MAGTF air, surface, and ground operations.

A sample of the SAAWC AAW Management tasks are as follows:

- Ensure ROE and target ID criteria are disseminated and strictly adhered to by weapons platforms and other AAW assets.

- Develop and maintain a thorough knowledge of number, types, locations and status of AAW assets allocated to assigned sectors and disseminate as appropriate.

- Coordinate with and brief higher adjacent and lower AAW agencies on an air defense plan for the assigned sector.

- Monitor the operational status of MACCS AAW agencies in the sector and direct/recommend system reconfiguration (to include movement) of assets to ensure optimum surveillance and weapons engagement functions are maintained.

2. Air Defense Communication Platform (ADCP)

The ADCP is a single configuration shelter capable of meeting the requirements for receiving and broadcasting air picture information for SHORAD units. The data will provide cuing/interface for Stinger, Avenger, LAV-AD (Light Armored Vehicle-Air Defense), and HAWK units. The ADCP serves as the interface between AN/TPS-59 and the HAWK fire unit for TBM defense. The ADCP will have five separate communications links. The most important of these will be the TADIL J link that permits direct communication between the ADCP, friendly aircraft, and other friendly forces.

For the TBM mission, the ADCP will transmit/receive TADIL J data for TBM only. The platform provides TADIL A receive, GBDL (Ground-Based Data Link), and IBDL (Intra-Battery Data Link) interfaces. Command and Control information, cueing information, and other information is provided between the TAOC and the ADCP via LAN and Point-to-Point links. This information is then provided to the BCP via a GBDL link, which in turn controls the HAWK Launcher via an IBDL link.

Add the ADCP to receive TBM tracks from AN/TPS-59 radars; to filter geographically any TBM data of interest to HAWK batteries; to propagate TBM tracks in time and space; to perform coordinate conversion and data formatting functions; and to provide connectivity to the joint data network [Ref. 12].

The ADCP provides a mission planning capability for HAWK/LAAD (Low Altitude Air Defense) commanders (no automation currently exists in air defense for this function). Finally, the ADCP will provide a "Building Block" capability for the MAGTF Commander to tailor air defense assets to better support the mission.

3. Tactical Digital Information Link J (TADIL J)

TADIL J (Link 16) is part of a joint service system known as JTIDS. JTIDS is interoperable with USN/USAF/USA/USMC/United Kingdom/France and NATO terminals. TADIL J will become an important netted data link between most TMD platforms, other forces, and allies by the year 2002. It will provide increased throughput, security, jam resistance, grid accuracy, and interoperability. Link 16 is the U.S. Naval/North Atlantic Treaty Organization (NATO) terminology for sets of netted links which allow for the exchange of tactical information among ships and aircraft in digital format in accordance with protocols and standards set forth in Navy Operational Specification 516 and NATO's STANAG 5516.

JTIDS supports a number of information transfer requirements for TMD. For example:

- Track data on target position, position uncertainty, velocity, and velocity uncertainty.

- Launch point estimation.
- Impact point and time of arrival.
- Warhead type and type confidence.
- Launcher locations.
- Track status.
- Intelligence data.
- Information management.
- Engagement coordination and status.

However, the most impressive aspect of JTIDS is the ability it gives to components of every service to possess the same digital display and voice communications system. This will facilitate communication throughout TMD's identify, track, and launch process.

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GLOSSARY (ACRONYMS)

AAW	Anti-Air Warfare
ABT	Air Breathing Target
ACE	Air Combat Element
ADCP	Air Defense Communication Platform
AEGIS	Automatic Electronic Guided Intercept System
AO	Area of Operations
BCP	Battery Command Post
BMC4I	Battle Management Command, Control, Communications, Computers and Intelligence
C2	Command and Control
C3I	Command, Control, Communications, and Intelligence
C4I	Command, Control, Communications, Computers, and Intelligence
COMM	Communications
CONOPS	Concept of Operations
COS	Command Operating Systems
CWAR	Continuous Wave Acquisition Radar
DOD	Department of Defense
EMCON	Emissions Control
ESM	Electronic Warfare Support Measures
FCR	Fire Control Radar
FOS	Family of Systems
HAWK	High Altitude Will Kill
HF	High Frequency
HPI	High Power Illuminator
IFF	Identification Friend or Foe
IPBDB	Intelligence Preparation of the Battlefield Data Base
JFC	Joint Forces Commander

JTF	Joint Task Force
JTIDS	Joint Tactical Information Distribution System
LAN	Local Area Network
MAGTF	Marine Air Ground Task Force
MCCDC	Marine Corps Combat Development Center
MEF	Marine Expeditionary Force
MRBM	Medium Range Ballistic Missile
NATO	North American Treaty Organization
NADGE	NATO Air Defense Ground Environment
NCCOSC	Naval Command, Control and Ocean Surveillance Center
PAR	Pulse Acquisition Radar
PATRIOT	Phase Array Tracking to Intercept of Target
SAAWC	Sector Anti-Air Warfare Center
SM2	Standard Missile 2
SOF	Sector Anti-Air Warfare Center (SAAWC) Operations Facility
SRBM	Short Range Ballistic Missile
SWD	Senior Weapons Director
TADIL	Tactical Digital Information Link
TAC	Tactical Air Commander
TACAN	Tactical Air Navigation Beacon
TACC	Tactical Air Command Center
TAOC	Tactical Air Operations Center
TAOM	Tactical Air Operations Module
TBM	Tactical Ballistic Missile
TBMD	Theater Ballistic Missile Defense
TCO	Tactical Combat Operations
TDMA	Time Division Multiple Access
THAAD	Theater High Altitude Air Defense
TMD	Theater Missile Defense

UHF	Ultra High Frequency
WAN	Wide Area Network

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